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MINI-RPV ROCKET LAUNCH TESTS.(U)
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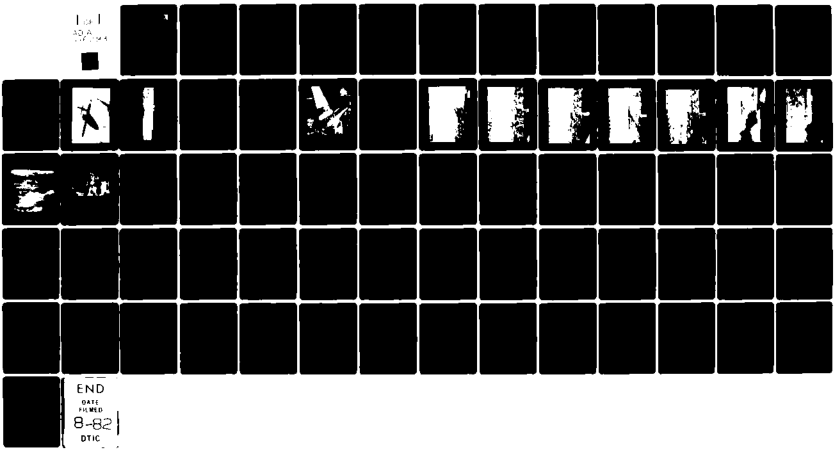

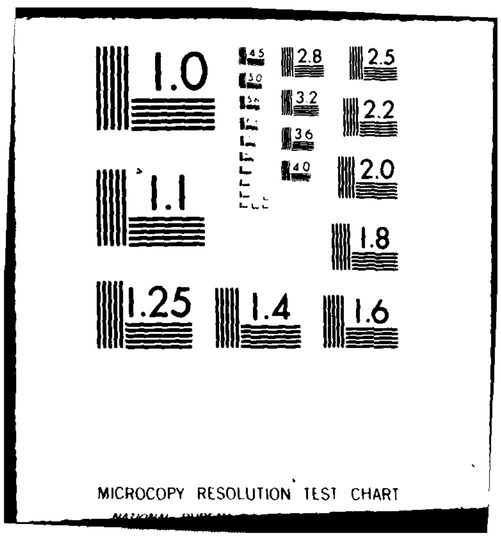
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MINI-RPV ROCKET LAUNCH TESTS

Author: James L. Koury

May 1982

Final Report for the period October 1980 to March 1982.

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

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AIR FORCE ROCKET PROPULSION LABORATORY
DIRECTOR OF SCIENCE AND TECHNOLOGY
AIR FORCE SYSTEMS COMMAND
EDWARDS AFB, CALIFORNIA 93523

NOTICES

FOREWORD

This report describes the results of a joint program between the Tactical Air Launched Missile Propulsion Section (MKAT) at the Air Force Rocket Propulsion Laboratory (AFRPL) and the Air Force Flight Dynamics Laboratory (AFFDL) to launch the Mini-Remotely Piloted Vehicle (RPV) using solid rockets. The launch tests were performed at the AFRPL on 24 and 25 September 1981 on Job Order No. 314812 MV. Special recognition is given to Messrs. D. Lowe, P. Pritts and J. Klein of AFFDL for their assistance. In addition, special recognition is given to Test Area 1-32 personnel, the photographic crew (AFFTC/OTC), Ms. P. Kalata (AFRPL/TSPV), and Mr. J. Sounder and MSgt. D. Brown (AFRPL/MKAT). This technical report is approved for release and distribution in accordance with the distribution statement on the cover and on the DD Form 1473.

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Launch Techniques for Mini-RPV
Retention/Ejection System
Rail Launch

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report covers the mini-RPV launch tests conducted at the AFRPL. The rocket motor development program conducted by ARC provided 13 booster motors, five of which were used in the launch tests. The mini-RPVs were launched to a velocity of 65 miles per hour from an aluminum rail of varying lengths (22, 14, 7 and 0 feet), using a nozzleless solid rocket booster. The final test demonstrated the capability of launching the mini-RPV from a platform.

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I. INTRODUCTION

The objective of this program was to demonstrate that it is feasible to use a solid rocket motor rather than the currently used pneumatic launcher to launch the mini-Remotely Piloted Vehicle (RPV). This report covers the technical efforts of both the Air Force Rocket Propulsion Laboratory (AFRPL) and the Air Force Flight Dynamics Laboratory (AFFDL) in preparing the mini-RPV and the booster motors, and in performing the actual launch tests.

AFRPL and AFFDL successfully launched five mini-RPVs on 24 and 25 September 1981. AFFDL provided the mini-RPVs, which were launched from an aluminum rail of varying lengths (22, 14, 7 and 0 feet) using a nozzleless solid rocket booster, and achieved a velocity of 65 miles per hour. The final test demonstrated our capability to launch the mini-RPV from a platform. Only five launches were needed to prove that it is feasible to use a solid rocket motor to launch a mini-RPV.

Atlantic Research Corporation (ARC) provided 13 booster motors under Contract No. F04611-80-C-0062. AFRPL used 5 of these motors in the mini-RPV launch tests. The rocket motor measured 2.38 inches in diameter by 21 inches in length and weighed 12 pounds. It was a case-bonded, nozzleless motor with 86 percent solid (aluminized HTPB) propellant. It contained 3.5 pounds of Class 1.3 propellant that produced about 2000 pounds of thrust during a 0.4-second burn time.

The booster motors proved to be reliable and compatible with the retention/ejection system. The rocket launch system provided a reliable, low-cost method of launching the mini-RPVs.

The mini-RPV and motor/mini-RPV interface performed exceptionally well. Video playback of each launch was an excellent tool to quickly evaluate booster performance, retention/ejection system performance, and overall performance of the mini-RPV. Still photos and movie film shot during the launch tests were examined later. AFRPL produced a documentary film which can be viewed at the AFRPL upon request.

2. BACKGROUND

Since 1971 the AFFDL has been developing Mini-Remotely Piloted Vehicle (RPV) technology. During this time, several vehicle designs have been developed and flight-tested. The most promising mini-RPV design is the XBQM-106, which has flown successfully in a number of AFFDL-sponsored flight test programs. The flight test results indicate the mini-RPV concept is a potentially viable "harassment" weapon system. As a result of these flight tests, a joint USAF/German program, titled "LOCUST," was initiated in 1979.

The mini-RPV system was designed to carry its own electronics to search and to seek out radar signals. Once it locates the radar signal, the mini-RPV will home in on the return signal, locate the site, and destroy it. The mini-RPV carries an explosive charge that detonates on impact.

The launch methods used in previous tests were a bungee-assisted cart system (Fig. 1) and a pneumatic launch system (Fig. 2). The bungee launch system was discarded because it required 400 feet of runway, which AFFDL considered too long. The pneumatic launcher that AFFDL presently uses is neither low-cost nor easy to operate, and is very bulky.

We needed a launch system that consisted of a short rail launcher and an energy source that would accelerate the mini-RPV to a stable launch velocity of about 65 mph. To maximize the flexibility of this approach, the AFRPL proposed that AFFDL use a low-cost solid rocket motor as the energy source for the mini-RPV. The solid rocket motor would offer the benefits of low cost, simple operation, ease of mobility, and flexible sortie launch rates.

During the last five years, the AFRPL has led in low-cost motor technology development. Much of AFRPL's effort has focused on demonstrating that it is feasible to achieve low cost using a nozzleless design. At the same time, AFRPL has tested a number of relatively inexpensive nozzle materials with adequate erosion resistance and physical properties which were successfully integrated into nozzled motor design. Studies demonstrated that small tactical rocket motors could be manufactured at least 20 percent cheaper in the nozzleless design than in the nozzled design. However, during a time when the cost of propellant ingredients has been rising, the advent of simpler, less expensive nozzles and insulation systems significantly reduces the cost advantage of the nozzleless configuration. Consequently, it is necessary to evaluate production quantity costs very carefully before deciding which configuration is more economical to produce.

A joint AFRPL/AFFDL program was initiated in 1979 to demonstrate the feasibility of launching the mini-RPV using a solid rocket booster motor. A Memorandum of Agreement was initiated between the two organizations to identify areas of responsibility. The AFFDL was responsible for developing the mini-RPV, providing the aluminum launch rail, and controlling the flight of the mini-RPV. The AFRPL was responsible for providing the solid rocket motor and conducting the launch tests.

A series of launch tests was planned to demonstrate the feasibility of using a solid rocket motor to rail-launch the mini-RPV. A minimum of 7 and a maximum of 13 launches were planned and scheduled within a 2-week period. During each approximately 10-minute flight, the mini-RPV was to reach an altitude of approximately 500 feet.

The AFFDL provided the mini-RPV, a 25-foot aluminum launch rail, a flight operator (pilot) and two installation mechanics. The AFRPL provided the solid rocket motors, prepared and conducted the flight tests, and arranged the support of the photographic crew. The AFRPL Test Area 1-100 Minuteman Silo was used as the site for launch and recovery. Personnel from Test Area 1-32 provided instrumentation and mechanical support for the launch tests.

3. TECHNICAL DISCUSSION

3.1 Rocket Motor

The maturity of solid propellant rocket motor technology that has occurred during the last 10 years has brought with it numerous and diverse new propellant systems, case and nozzle materials, and fabrication techniques. Today the availability of such a large number of design alternatives allows more options in the selection of components and configurations than were available to the previous generation of rocket motors. This makes it possible to minimize cost at an earlier and more effective stage during design and development. Consequently, it is necessary to evaluate production quantity costs very carefully before reaching a conclusion as to which motor design (nozzled versus nozzleless) is more economical to produce.

Because private industry has an extensive cost data base at their disposal, the AFRPL solicited their help in the design, fabrication, test, and manufacture of the low-cost motors for the mini-RPV launch tests. The ARC was awarded the fixed price contract, F04611-80-C-0062. I do not include the efforts expended by ARC in this report. AFRPL-TR-81-78(C), "Mini-RPV Rocket Booster Development," describes ARC's test results. Motor performance (such as thrust, chamber pressure, burn time, etc.) is discussed in that report.

ARC's goal was to develop a low-cost booster capable of accelerating the mini-RPV to launch velocity within approximately 0.4 seconds. Thirteen boosters were successfully static tested at ARC throughout the program, and thirteen were delivered to the AFRPL for the launch tests. The motor design selected for the demonstration was a case-bonded, nozzleless motor with 86 percent solids (aluminized HTPB propellant) (Fig. 3). The motor measured 2.38 inches in diameter by 21 inches in length and weighed 12 pounds. It contained 3.5 pounds of Class 1.3 propellant that produced about 2000 pounds of thrust during a 0.4-second burn time. The data from ARC's detailed cost study showed the nozzleless motor design was about 15 percent cheaper to produce in large quantities than any of the nozzled designs. Details of this cost analysis can be found in AFRPL-TR-81-78(C).

3.2 Mini-RPV

The XBQM-106 was designed in 1975 as a flexible testbed vehicle in the general size class envisioned for harassment and expendable strike mini-RPVs. Two XBQM-106s were built for this particular effort (see Appendix). The dimensions for the mini-RPV are shown in Figure 4. The aircraft, constructed primarily of fiberglass/epoxy and foam materials, is a conventional monoplane propelled by a single 2-cycle engine which is arranged in a pusher fashion. The two vehicles were shown to be compatible with the Fairchild Stratos Pneumatic Launcher. Both planes were launched and flight-tested by AFFDL before they were shipped to the AFRPL.

3.3 Retention/Ejection System

The mini-RPVs were modified to carry the solid rocket motor in the tail of the airplane as shown in Figure 5. A 60-mil copper wire holds the rocket motor in place, inside the opening of the RPV. The wire is strung across the aft end of the motor and attached to the two pins on the RPV as shown in Figure 5. As tested during the ARC program, the wire had no detrimental effect on the motor ignition system. The ejection system consisted of a spring that ejects the spent motor case. The copper wire holds the spring in compression, and the wire is burned during motor operation. The motor pressure keeps the spring compressed until burnout, at which time the spring expands, ejecting the motor case from the mini-RPV.

4. LAUNCH TESTS

4.1 Pre-Launch Preparations

In addition in installing the aluminum launch rail at Test Area 1-100, AFRPL performed the following tasks. A countdown committee reviewed and approved the mini-RPV launch plan, system safety program plan and hazard analysis. They presented the results to Colonel Allan J. MacLaren, Deputy Director of the AFRPL, on 21 September 1981. This review included risk assessment, test objectives, test article readiness, hazard analyses, and the sequence of events as planned before each launch.

Each morning the ground around the launch area was sprayed with water to reduce the dust created by the activation of the engine of the mini-RPV and the booster. The tracker was placed in position and cameras were mounted on the tracker and adjusted before the first launch. The tracker was located 600 feet behind and 25 degrees to the right of the launch rail, which provided maximum personnel safety and camera position. After the mini-RPV was fueled and checked at Test Area 1-32, it was taken to the launch area, Test Area 1-100.

The mini-RPV was installed on the launch rail using the wooden launch blocks to guide the mini-RPV down the rail to the predetermined launch position, as shown in Figure 6. The wooden blocks guided the mini-RPV off the rail, and the blocks were ejected after launch as shown in Figure 13.

Just prior to each launch, the following sequence of events occurred. The mini-RPV engine was started and the flight control system checked. When the flight control check was completed, the rocket motor was installed in the aft section of the mini-RPV. Once the motor was secured in the mini-RPV, the fire control system was checked, and igniter leads were connected to the rocket motor igniter. The test conductor, pilot, camera crew chief, and mechanical crew chief used two-way radios and flags to communicate with one another during the installation and check-out phases.

4.2 Launch

We successfully launched five mini-RPVs on the 24th and 25th of September, 1981. The mini-RPVs were launched to a velocity of 65 mph from an aluminum rail of varying lengths (shown in Fig. 5) using a nozzleless rocket booster. After each launch, we reviewed the video playback to evaluate the effectiveness and performance of the booster, the retention/ejection system, and the mini-RPV. Mr. Don Lowe of AFFDL, who piloted the mini-RPV, provided his personal evaluation of the aerodynamic performance of each launch of the mini-RPV. Because of our ability to quickly examine and evaluate each flight using video playback, we were able to complete the tests within two days. The following is a brief discussion of each of the five launches.

The first launch position was 22 feet (Fig. 7). Two successful launches were performed at this position on 24 September 1981. After completion of the first launch, we noticed the copper wire did not burn through. We determined the vibration of the motor had caused it to slip off the center line of the motor. To prevent a recurrence, a hose clamp was notched and installed on the aft end of the motor that extended past the edge of the motor case. The wire was then strung through the notches to keep the wire in place. This fix was used for the remaining launches, and no further problems were encountered.

The excellent results of the first two launches dictated our decision to shorten the launch position from 22 feet to 14 feet. The next two launches that occurred on the morning of 25 September 1981 were at 14 feet and 7 feet respectively, as shown in Figures 8 and 9. Both launches were successful. Mr. Lowe noticed during these two launches that the mini-RPV was pitching upward when it left the rail. The cause for the pitch-up was associated with the motor burning at launch and during the early part of the flight. However, the pilot easily corrected for this using the mini-RPV remote flight controls.

Because of our continued success, we decided after four launches to attempt a zero launch condition. The fifth and final launch occurred on the afternoon of 25 September 1981. The launch position was set at zero feet as shown in Figure 10. This final test successfully demonstrated our capability to launch the mini-RPV from a platform using a solid rocket motor.

A typical motor ignition, launch, and motor case ejection are shown in Figures 11, 12, and 13. The mini-RPVs were launched and landed into a wind ranging in velocity from 15 to 25 knots, and the mini-RPV landings were made on an asphalt road adjacent to the launch rail. After each launch, the spent motor case landed approximately 200 feet from the launch rail, as shown in Figure 4.

4.3 Video/Camera Coverage

AFRPL/TS provided excellent video coverage of each launch. By viewing the quick-look video tapes after each flight, we were better able to select the rail length for the following launch. The video coverage allowed us to shorten the duration for the launch tests to two days instead of two weeks, as originally planned.

Five cameras mounted on a tracker were located 600 feet from the launcher. Camera speeds of 400, 96, 64, and 48 frames per second (fps) and 24 fps (real time) were used. The photographic crew provided three hand-held cameras placed in the same locality. The photographic crew and tracker are shown in Figure 14. Stills and motion picture films were used during the final evaluation of the test results.

5. CONCLUSIONS

We successfully demonstrated the feasibility of using a solid rocket motor to launch the mini-RPV.

The nozzleless rocket motor is the lowest cost solid rocket motor for this application.

The final launch test demonstrated the capability of launching the mini-RPVs from a platform which eliminates the need for a rail. This approach offers many benefits, such as low cost, simple operation, ease of mobility, and flexible sortie launch rates.

6. RECOMMENDATIONS

We recommend that the rocket launch concept be incorporated in future mini-RPV systems to replace the currently used pneumatic launcher.

We recommend that a cost comparison study be performed on both the rocket system and the pneumatic launch system before selecting the launch concept.

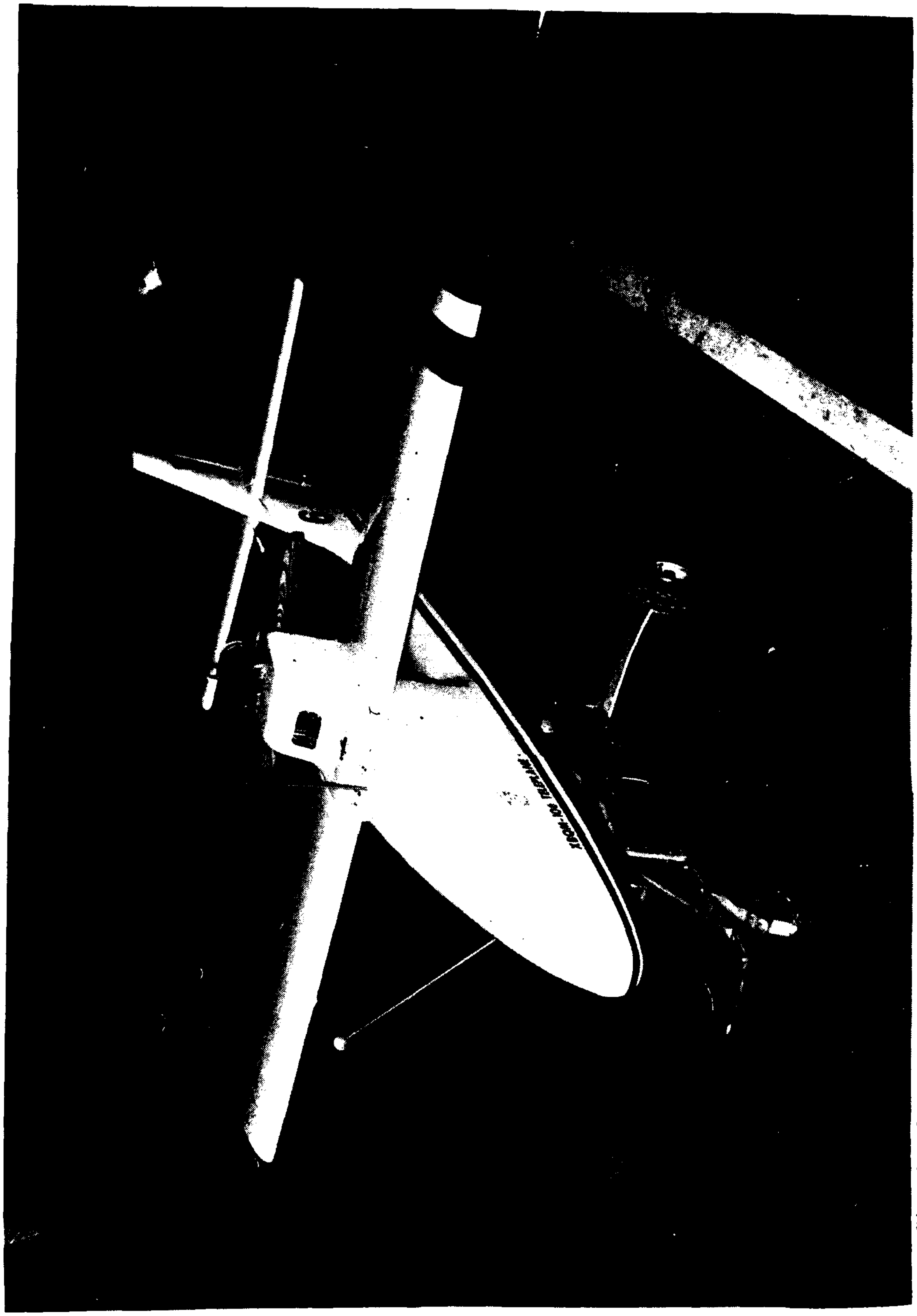


Fig. 1. Bungee- Assisted Cart System.

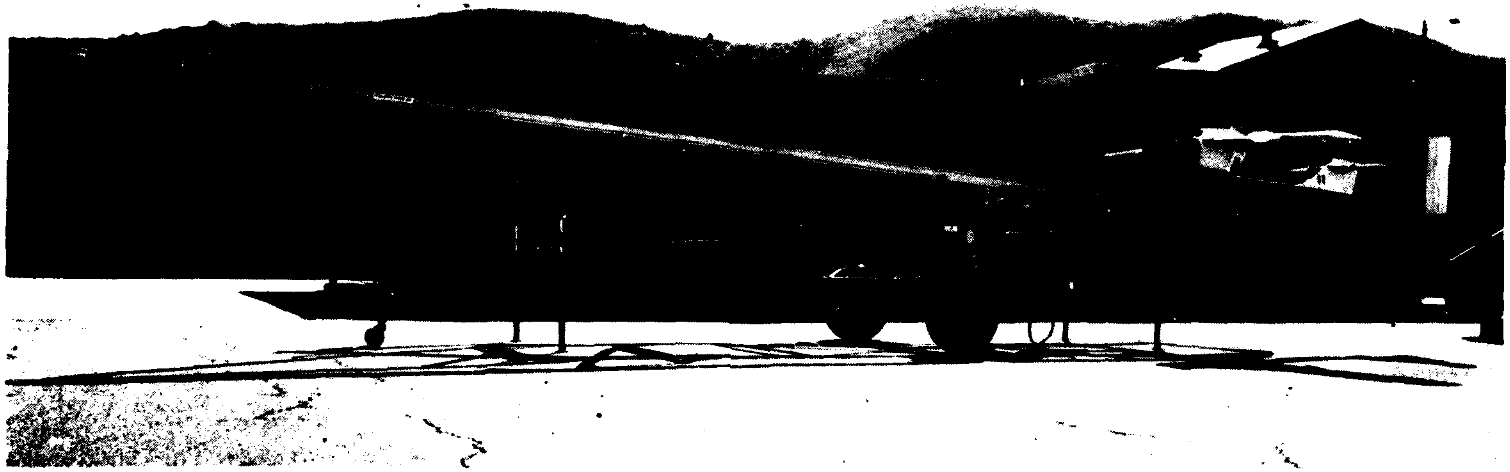


Fig. 2. Pneumatic Launch System.

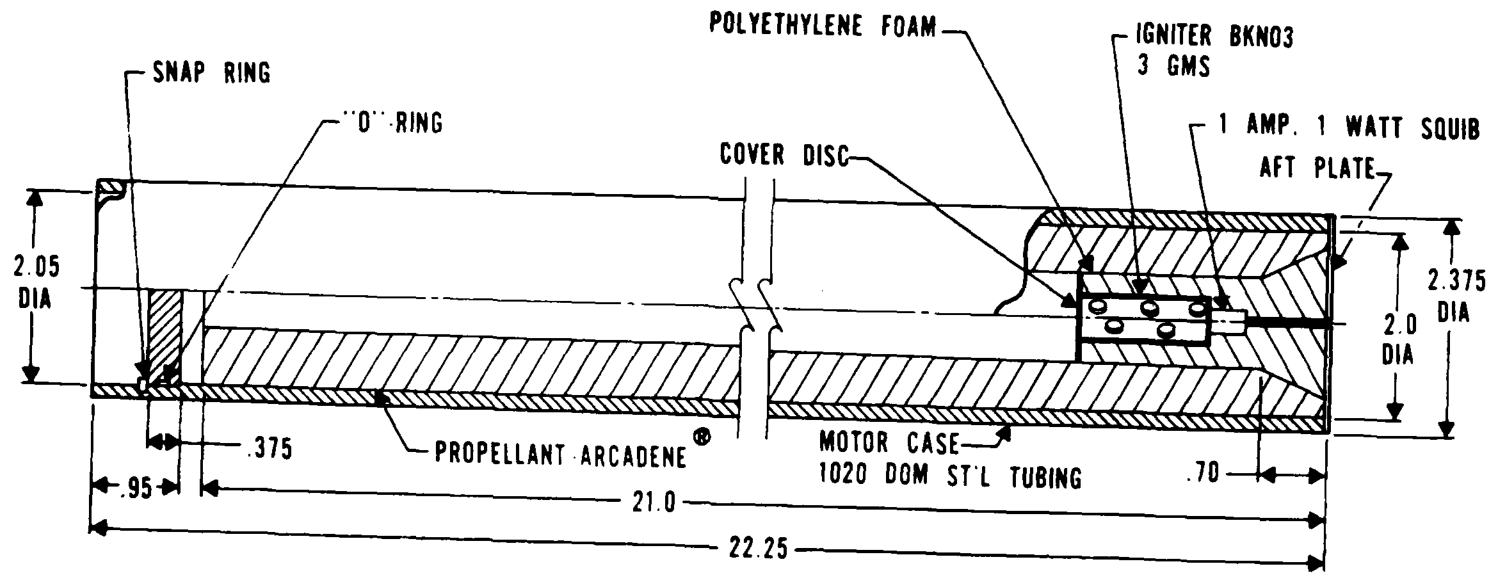


Fig. 3. Solid Rocket Motor Design.

MINI RPV DESIGN SPECIFICATIONS....

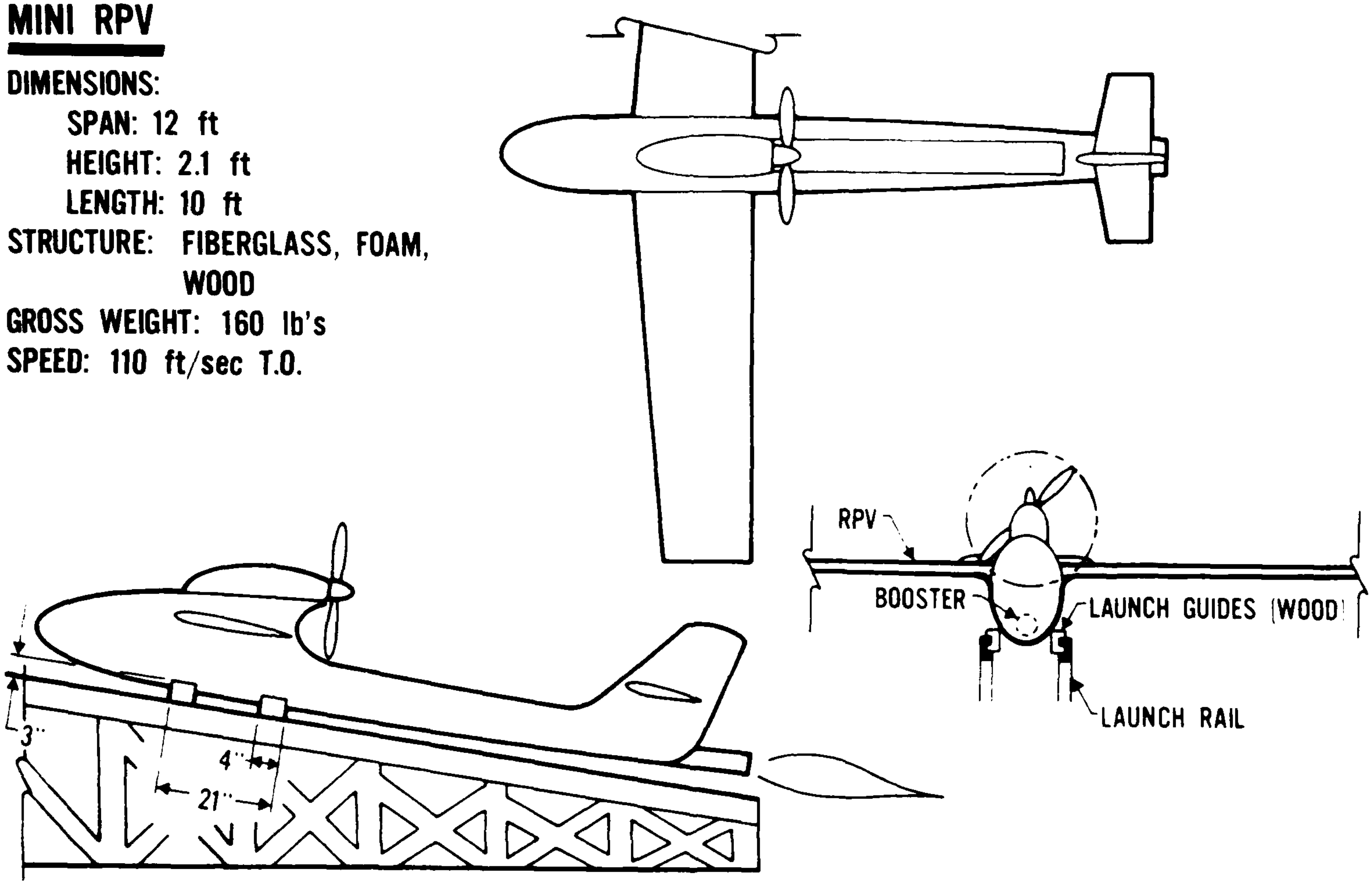
MINI RPV

DIMENSIONS:
- SPAN: 12 ft
- HEIGHT: 2.1 ft
- LENGTH: 10 ft

STRUCTURE: FIBERGLASS, FOAM, WOOD

GROSS WEIGHT: 160 lb's

SPEED: 110 ft/sec T.O.



RAIL LENGTH: 25 ft

Fig. 4. Mini RPV Design Specification.

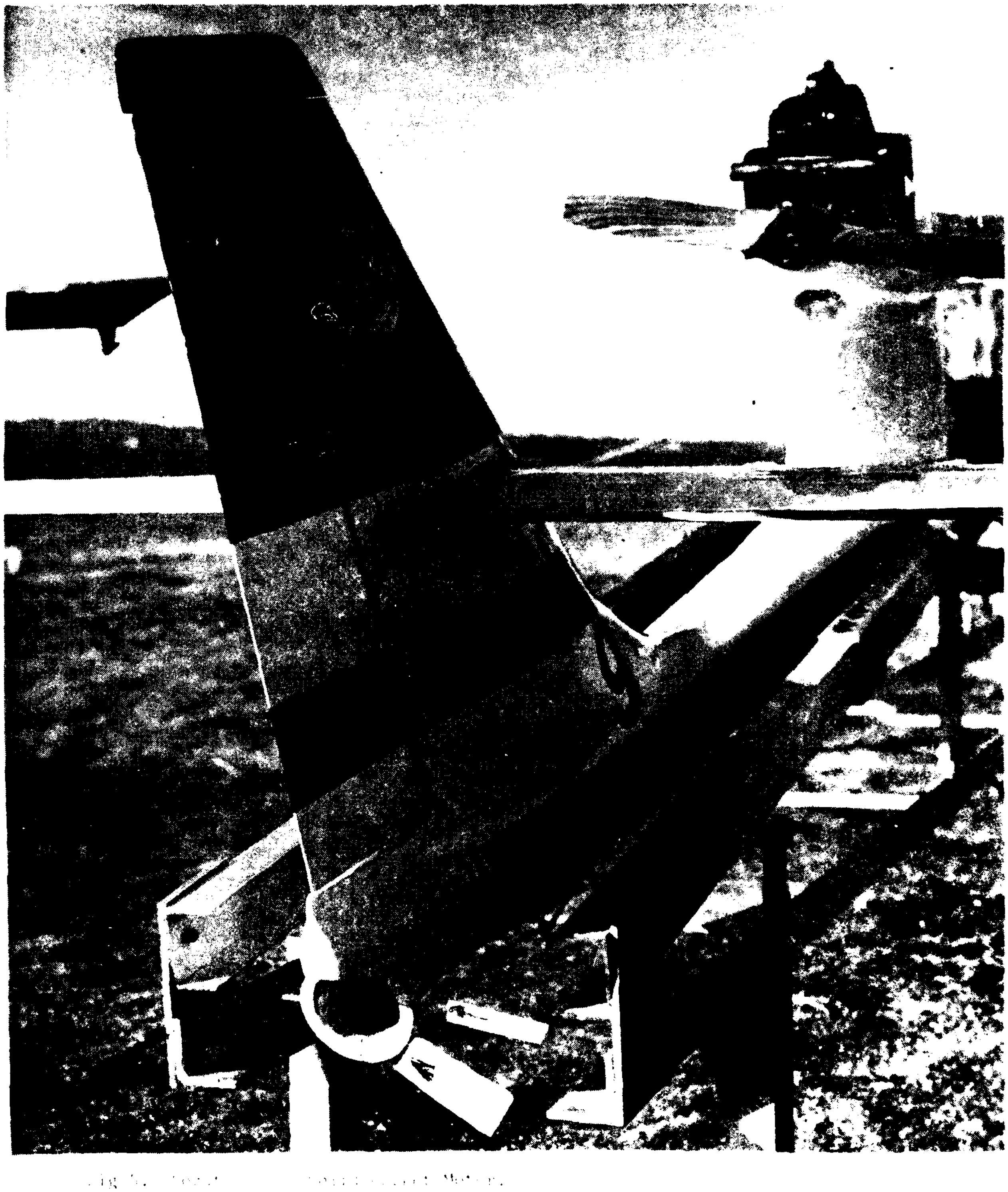


Fig 5. [illegible] Motor.

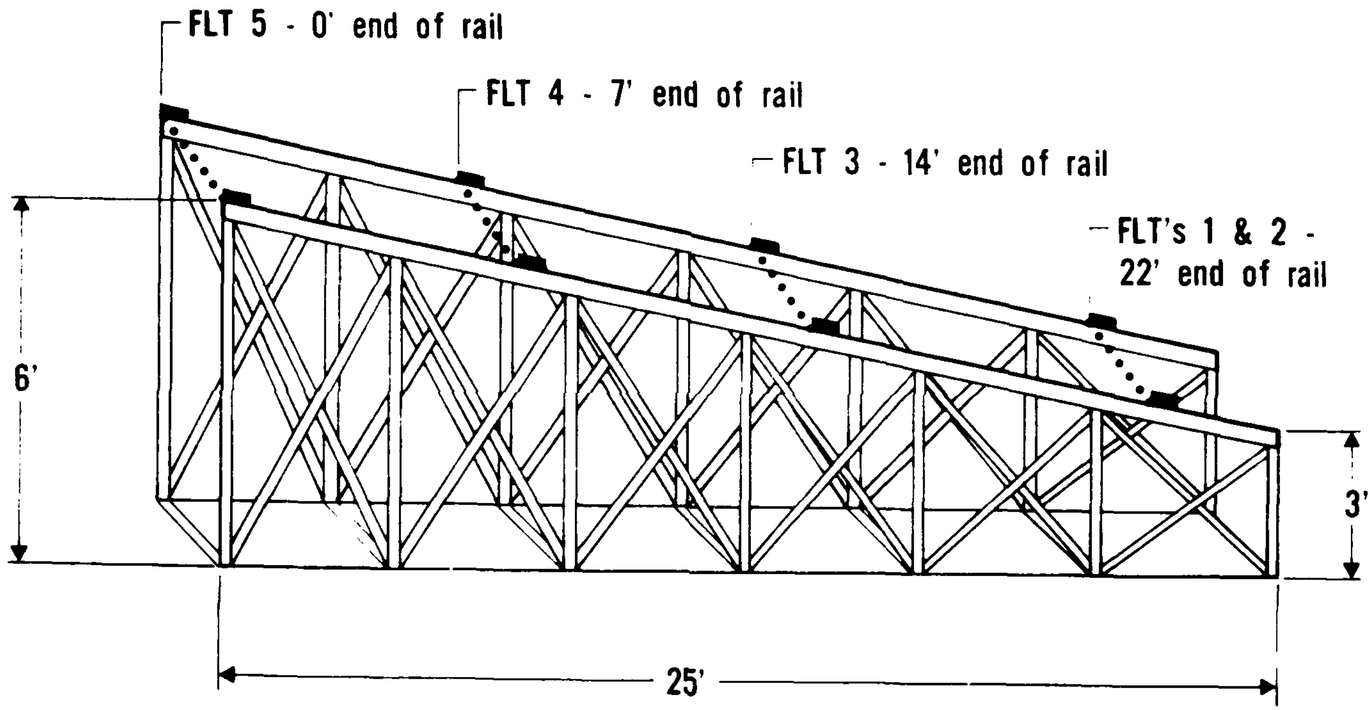


Fig. 6. Aluminum Rail Showing the Varying Launch Lengths.

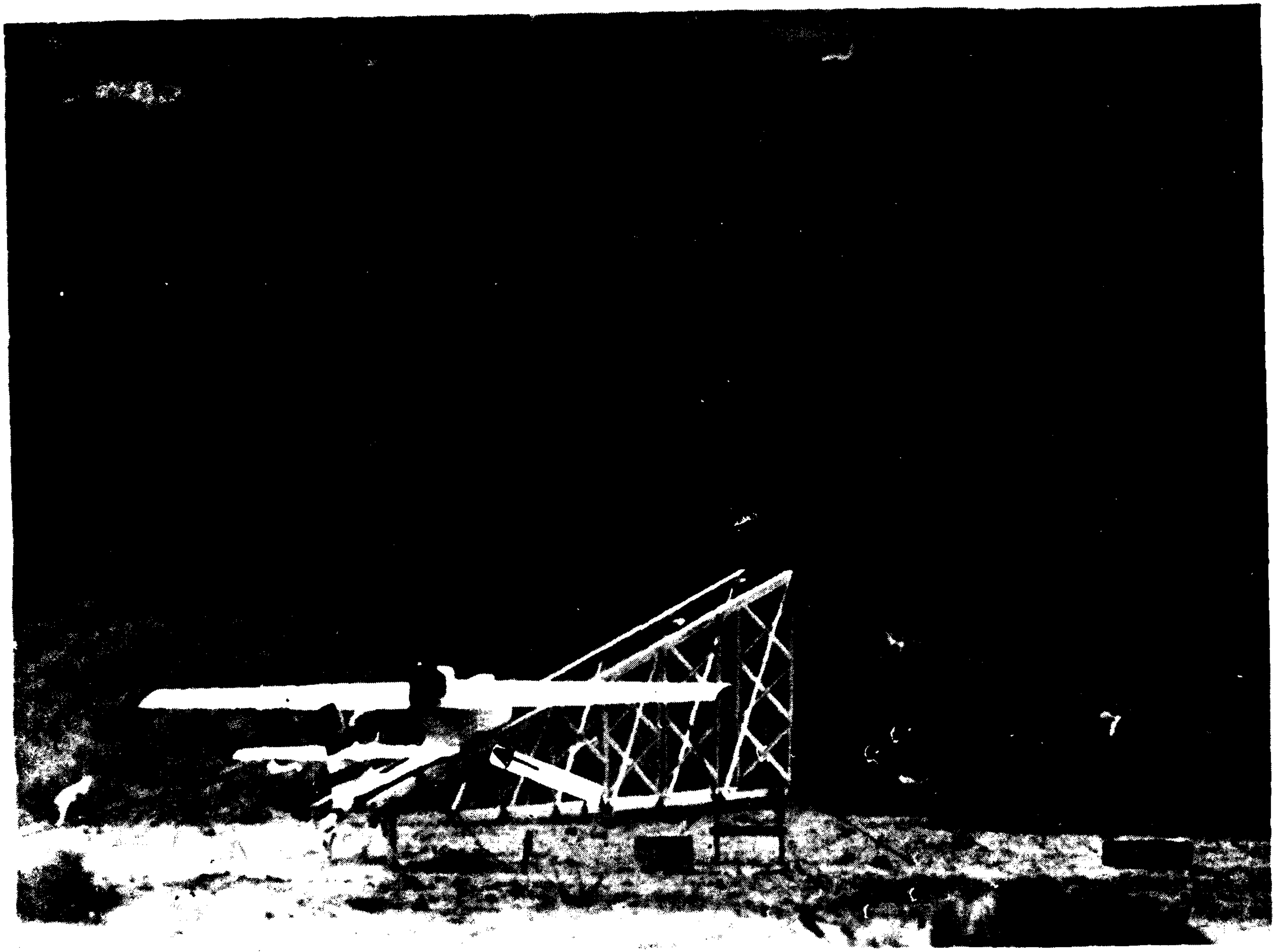


Fig. 7. Mini RPV Launch, Nos. 1 and 2.

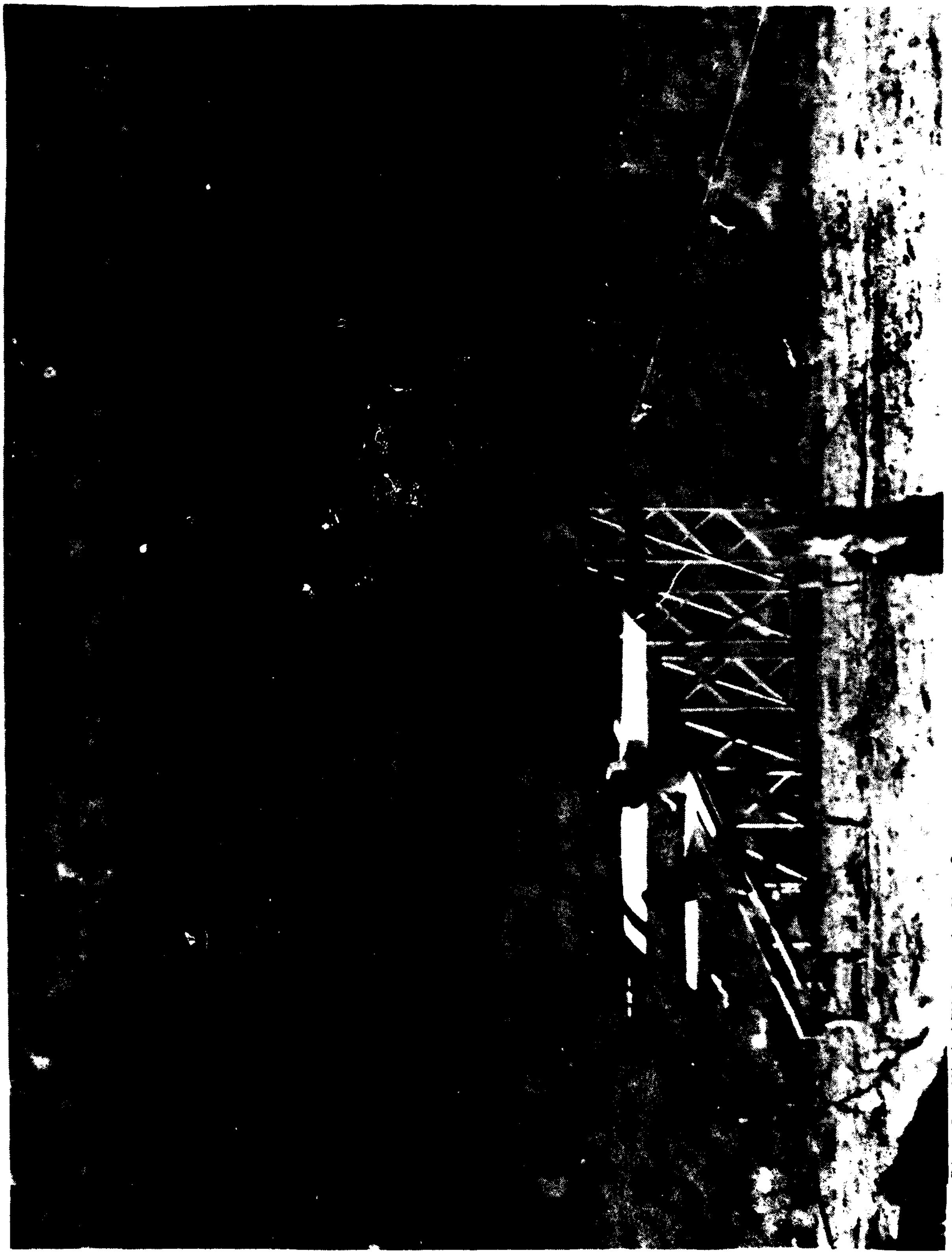


Fig. 8. Mini-RPV Launch, No. 3.

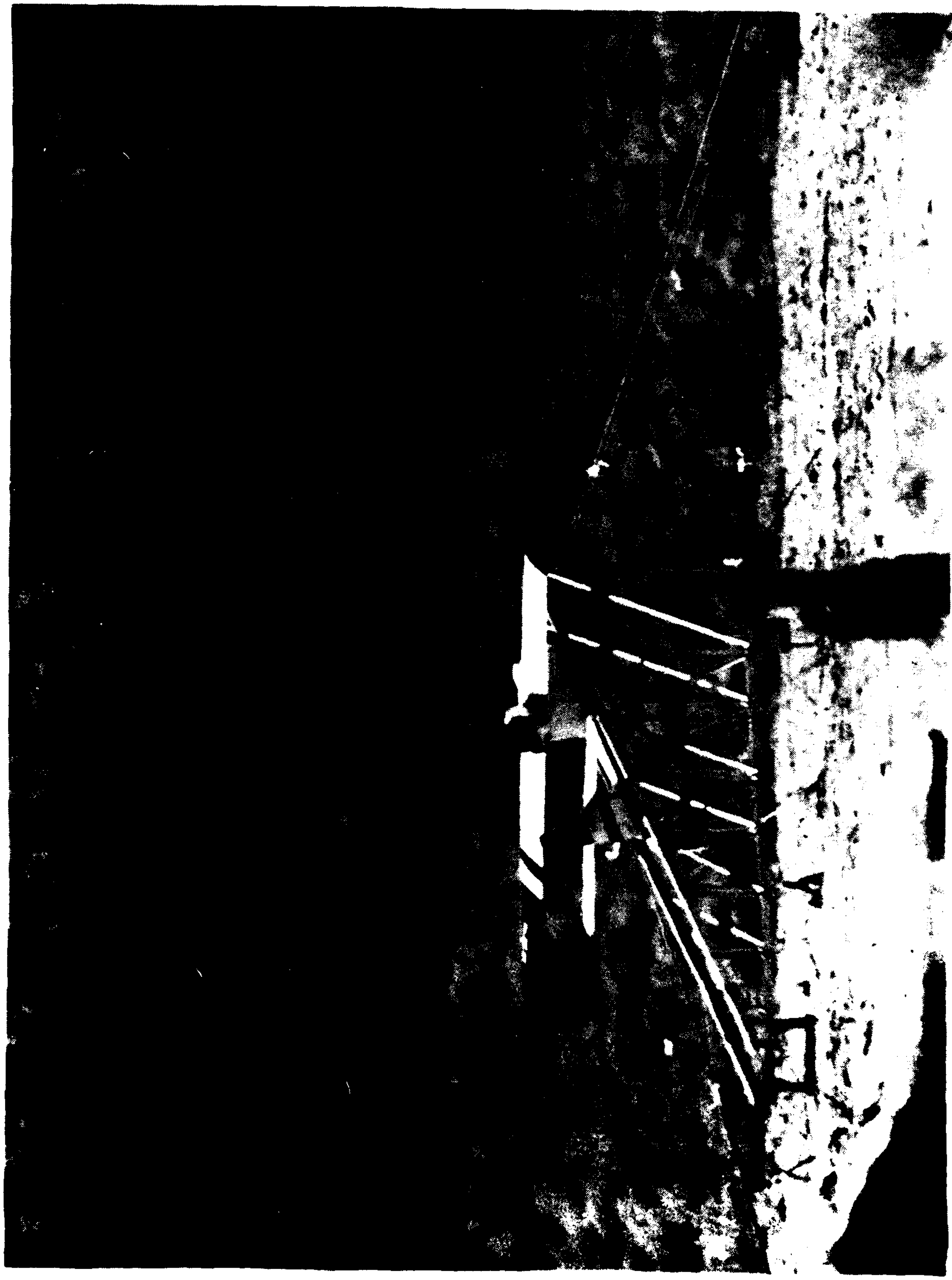


Fig. 9. Mini-RPV Launch, No. 4.

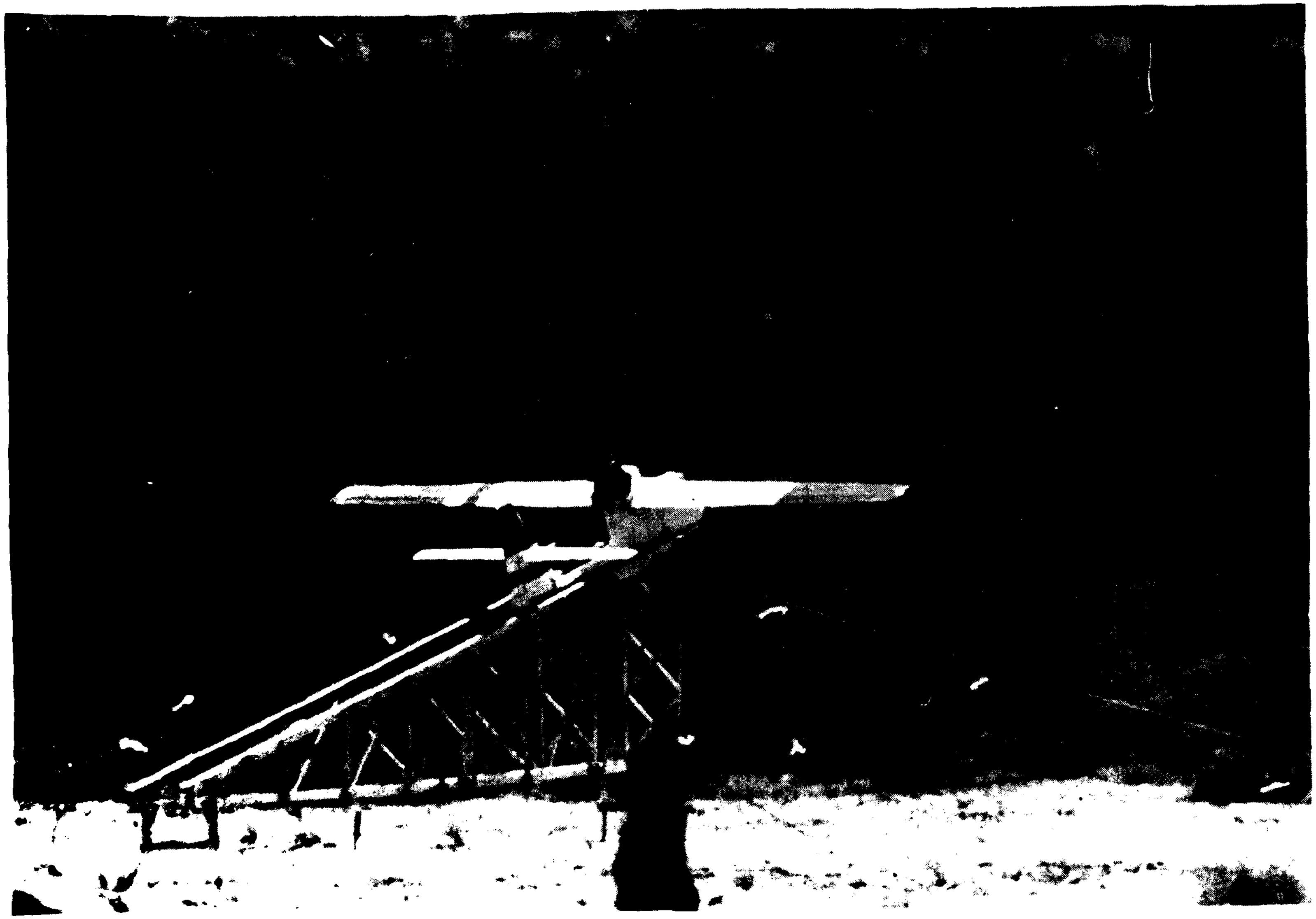


Fig. 10. Mini-RPV Launch, No. 5 (Zero Length).

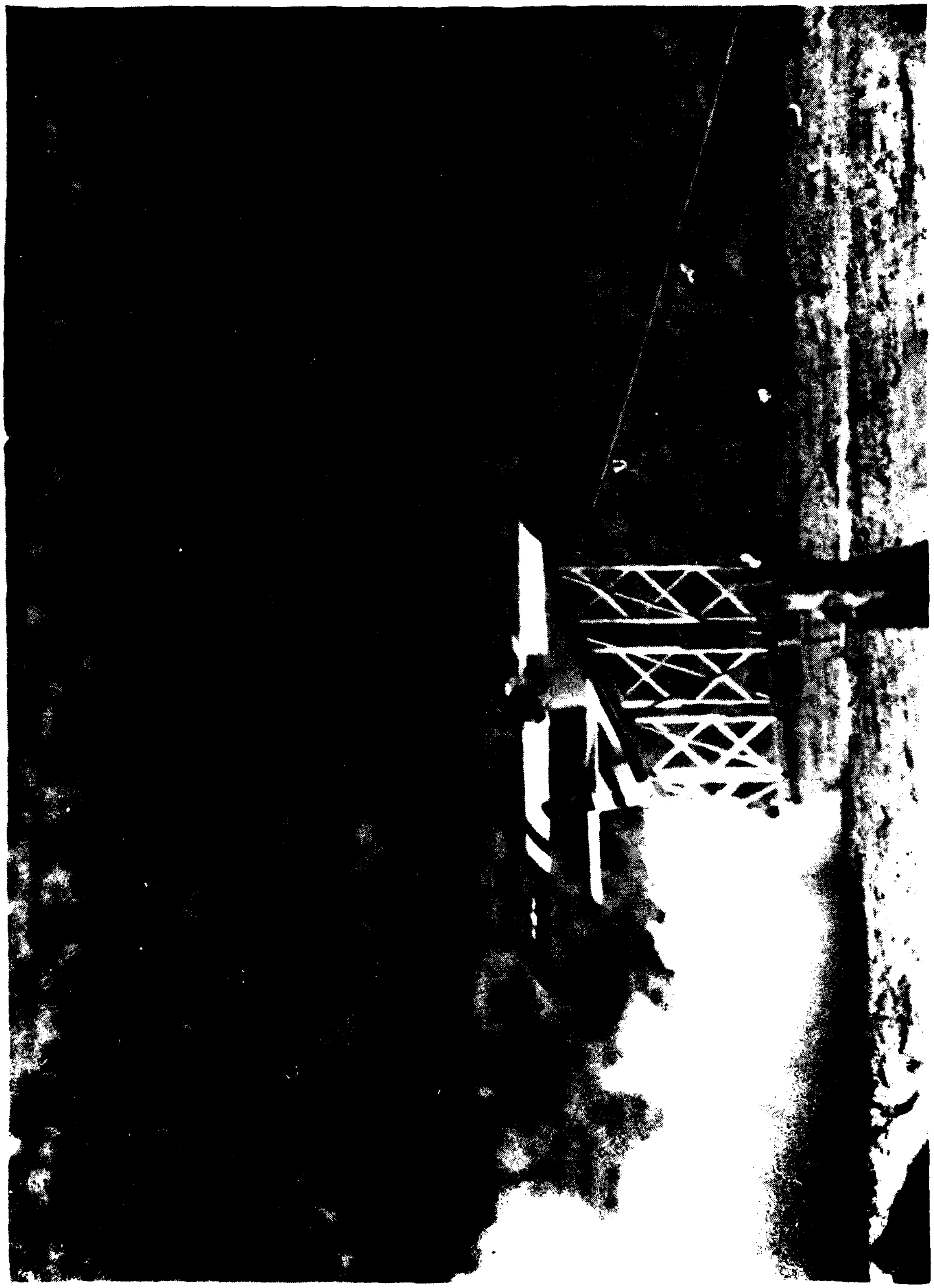


Fig. 11. Motor Ignition.

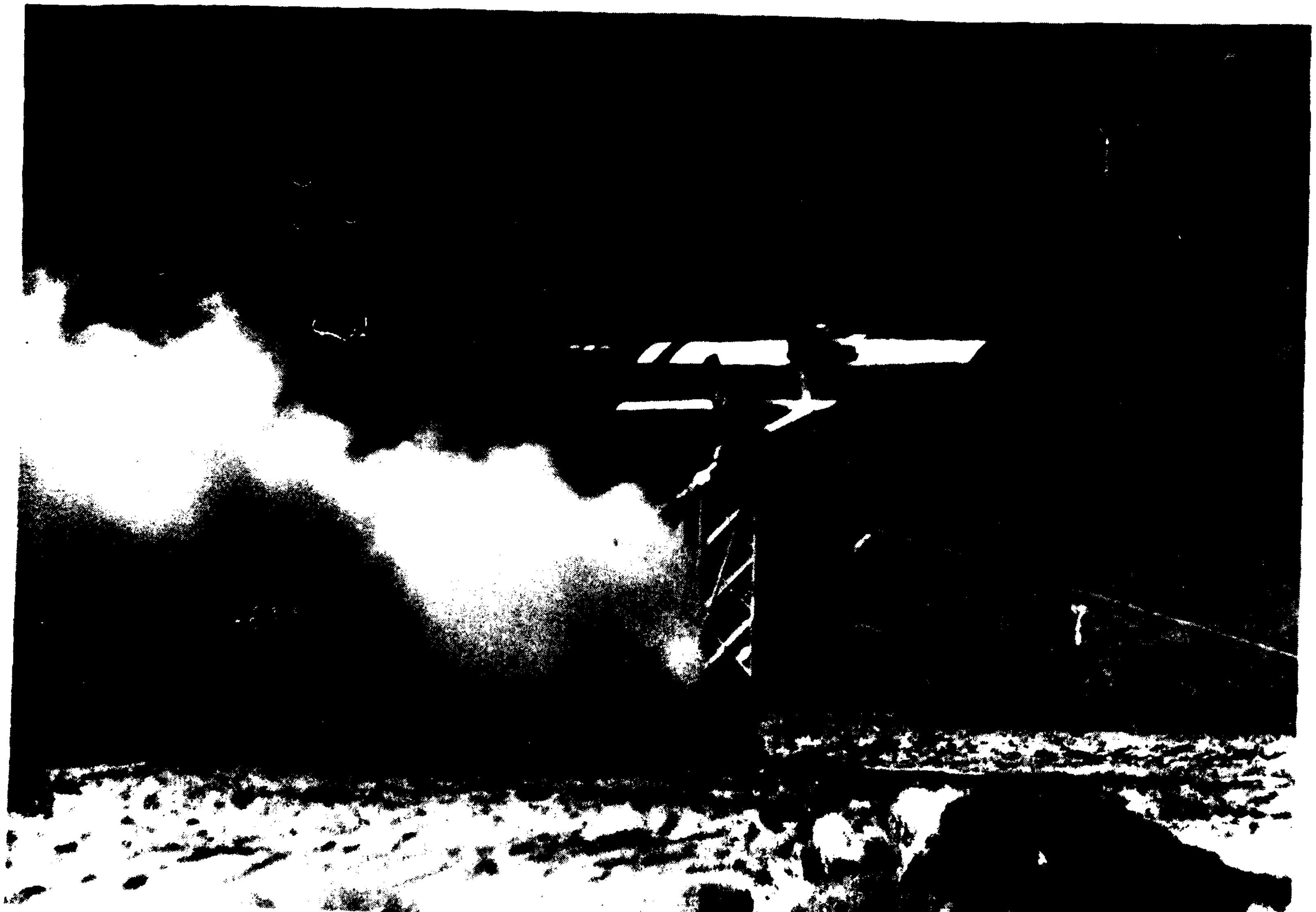


Fig. 12. Mini-RPV Launch.

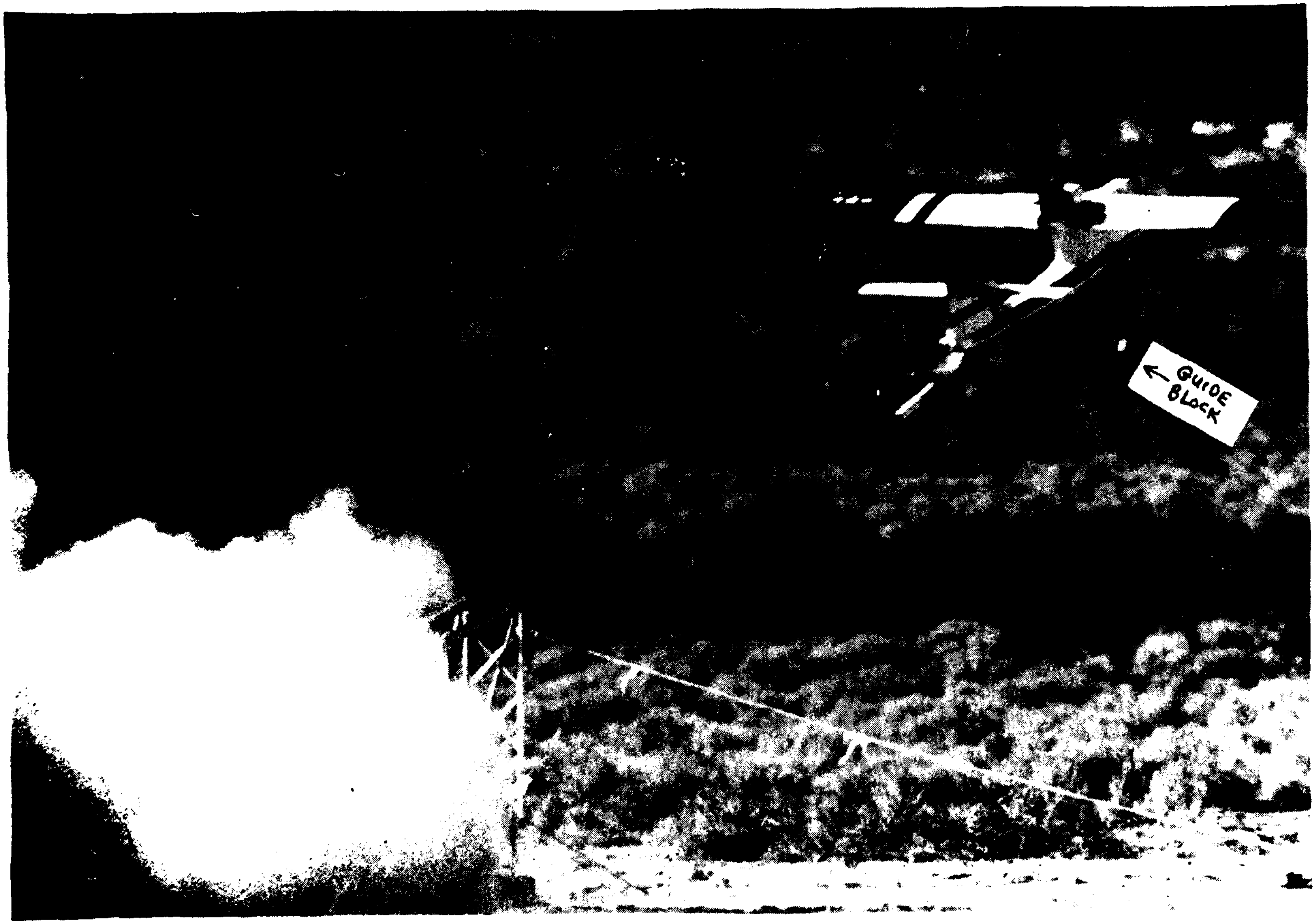


Fig. 13. Motor Case Ejection.

Fig. 14. Spent Motor Case After Ejection.

Fig. 15. Tracker and Photographic Crew.

<u>XBQM-106</u>

<u>SPECIFICATIONS AND DESCRIPTION</u>

AFWAL/FIMS

MINI-RPV GROUP

1.0 INTRODUCTION

The XBQM-106 was designed in 1975 as a flexible testbed vehicle in the general size class envisioned for harrassment and expendable strike Mini-RPVs. A conventional monoplane pusher configuration was selected for its clean nose, simplicity of design, and good stability. A modular assembly was incorporated to allow substitution of wing and tail surfaces, engine, nose section, and payload packages for evaluation.

In 1975, the XBQM-106 was selected by the ASD RPV/SPO for evaluation of air to surface missions with this class of vehicle. To simplify and reduce the cost of terminal guidance systems, a program was undertaken to minimize aerodynamic control coupling in the vehicle. The current configuration is the output of the program. At the same time, a series of side force fins was tested to optimize the vehicle for wings level terminal guidance steering. The mid-span fins finally selected produced significant turn rate improvement with little aerodynamic coupling.

The current version of the XBQM-106 is an excellent flying vehicle in stabilized and non-stabilized control modes. Control coupling between all axes is minimal. Damping in all axes and directional stability is very good; spiral stability is intentionally neutral. The airplane is normally launched from a pneumatic rail launcher or bungee assisted cart. It lands on a replaceable skid affixed to the underbody.

The following tables and drawings describe the historical, physical, and performance data of the XBQM-106. It is noted that most performance data are for a 140# airplane. It has flown many missions at weights in excess of 225#. The vehicle still flys well at the heavy weight condition with a larger engine.

The intent of this document is to establish Mini-RPV airframe requirements and to define those elements of the air vehicle which will interface directly with autopilot and seeker hardware. Requirements specified in this document include:

1. Airframe general arrangement and equipment supplied.
2. Payload/seeker shroud design and forward bulkhead interface.
3. Servo/linkage specification and test procedure.
4. Control surface position potentiometer specification.
5. Miscellaneous.
6. Environments.

1.1 AIRFRAME DESCRIPTION

The basic airframe is the XBQM-106 Mini-RPV as represented by those aircraft with tail numbers 18-22 built for the USAF "HAVE PAWN" Program. The aircraft are compatible with the Fairchild Stratos Pneumatic Launcher (P/N X7752001).

1.1 AIRFRAME DESCRIPTION (Continued)

A general arrangement drawing (FIMS-024) of the aircraft depicting the standard or basic nose configuration is shown in Figure 1. The vehicle specifications are as follows:

VEHICLE DESCRIPTION

The XBQM-106 vehicle is a conventional monoplane using a single 2 cycle engine for propulsion arranged in pusher fashion. The nose is tailored to fit the customer requirements within acceptable aerodynamic and C.G. limits. Vehicle gross weight is usually in the vicinity of 200# dependent on final experimental seeker weights and instrumentation. A list of nominal component weights is included in Figure 3.

The aircraft as delivered usually includes the following installed items:

1. Wing (FIMS 007 and 009), tail, fuselage, payload shroud and engine cowl structures.
2. Wing and tail aluminum spars, aileron and stabilator hinging and actuation mechanism.
3. Replaceable forward landing skid and aft ventral fin.
4. Replaceable side force surfaces (2), and installation spars and fittings.
5. Fuel tank, plumbing and filter. (2.8 gal. capacity)
6. Engine - DH Enterprises 220 - 18 HP.
7. Propeller - 26" dia. X 13" pitch.
8. Engine/alternator mount - special shock mounting using three "Aeroflex" mounts (FIMS-025).
10. Voltage Regulator - KBG model 10227.
11. L-band antenna and coax - KBG model 10102
12. Servos [aileron (2), throttle (1), elevator (1), rudder (1)] - KBG model 10344.
13. Battery pack - lead acid, 26 volt, 2.5 amp HR.
14. Wiring harnesses - wing; servos, control position pots and magnetometer; fuselage, servos, battery, alternator.
15. Pitot tube and plumbing - Centro model no C-5255.
16. Engine CD ignition unit - KBG model 10308.
17. Control surface position pots and mounting - KBG model 10145.
18. Magnetometer (wing tip) mount bracket - KBG 10195.
19. Charge plug - DAMA - 15S Crimp type.

1.2 PAYLOAD INTERFACE

The payload package/seeker includes an antenna array and TV camera, plus associated electronic hardware mounted on the forward bulkhead (STA-0.75) using the fastener pattern and cable routing limitations defined in Figure 2. The payload structure is supplied and installed by the system integrator.

The aircraft is constructed primarily of fiberglass/epoxy and foam materials with identical methods as used for "HAVE PAWN" vehicles. At 200#, vehicle load limits will approximate $\pm$ 5.5gs in pitch, 2.0gs yaw, and 10gs longitudinal for launch. Flight performance will be as limited by the DH 220 engine driving a 26" dia. X 13" pitch propeller.

Vehicle specifications are as follows:

WING

Area:	19.2 Sq ft
Span:	143 in
Tip Chord:	16.75 in
Root Chord:	22 in
Tip Airfoil:	NACA 2515
Root Airfoil:	NACA 2512
Root Incidence:	3.5 deg
Washout:	3 deg
Dihedral (Γ):	0.1 deg per panel
1/4 Chord Sweep(Λ):	2.75 deg
Aileron Span:	25 in
Aileron Tip Chord:	3.5 in
Aileron Root Chord:	4 in
Aileron Deflection:	15 deg T.E. up 10 deg T.E. down

HORIZONTAL TAIL

Area:	3.82 Sq ft
Span:	50 in
Tip Chord:	9 in
Root Chord:	13 in
Tip Airfoil:	NACA 0012
Root Airfoil:	NACA 0012
Root Incidence:	0 deg
1/4 Chord Sweep(Λ):	4 deg
Stabilator Pivot Point:	24% m.a.c.
Stabilator Deflection:	$\pm$ 8 deg

VERTICAL FIN

Area:	2.75 Sq ft
Span:	22 in
Tip Chord:	10 in
Root Chord:	26 in
Tip Airfoil:	NACA 63_2 A021
Root Airfoil:	NACA 64_1 A011.5
1/4 Chord Sweep(Λ):	39 deg
Rudder Span:	20.5 in
Rudder Tip Chord:	3.5 in
Rudder Root Chord:	7 in
Rudder Deflection:	$\pm$ 15 deg
Subfin Area:	1.0 Sq ft
Subfin Length:	30 in
Subfin Depth:	5 in
Subfin Airfoil:	NACA 0006.3 - 34 (mod)

MID-SPAN SIDE FORCE SURFACE

Area:	1.9 Sq ft
Span:	16.5 in
Tip Chord:	16 in
Root Chord:	19 in
Tip Airfoil:	NACA 0008 - 34 (mod)
Root Airfoil:	NACA 0006.7 - 34 (mod)
1/4 Chord Sweep(Λ):	2.6 deg

FUSELAGE

Overall Length:	122 in
Max Width:	9 in
Max Height:	26.5 in
Nose Length:	30 in
Tailboom Diameter:	6 in by 9 in oval at front 4 in in dia. circle at rear
Payload Volume:	1.55 cu ft in nose 1.26 cu ft under wing

PAYLOAD SHROUD

The payload shroud will be designed and constructed by the airframe fabricator and will fit the payload package as defined by the system integrator. The shroud shall be fastened around the forward fuselage bulkhead. The material used for construction shall be fiberglass and epoxy resin. The shroud shall be an aerodynamic fairing only and will not support any significant portion of the payload.

1.3 SERVO SPECIFICATION

1.3.1 BACKLASH (peak to peak as installed)

Elevator	0.65° max
Aileron	1.0" max
Rudder	1.75° max
Throttle	3% max with spring tension

1.3.2 SERVO TORQUE AND POWER

300 ma max (28V) @ 10 in-lb

400 ma max at stall (18 in-lb with 62.5 Hz pulse frequency

Stall torque tolerance 14 - 18 in-lb

1.3.3 FREQUENCY RESPONSE

1.0 Hz min (-3db) at $\pm 20^{\circ}$ deflection

No load, assuming $\pm$ 45 degree servo

1.3.4 POSITION DRIFT DUE TO TEMPERATURE (32°F to 120°F)

$\pm$ 10% full scale max for control surfaces

Full control for throttle servo

1.3.5 TRIM

Elevator	0 $\pm$ 0.5 deg
Aileron	0 $\pm$ 0.75 deg
Rudder	0 $\pm$ 1.0 deg
Throttle	50% $\pm$ 5%

1.3.6 SCALE FACTOR (5%)

Elevator	20 ± 1 deg/msec
Aileron	31.25 ± 1.56 deg/msec
Rudder	62.5 ± 3.13 deg/msec

1.3.7 POWER

Operate from 28±4 VDC supply

1.3.8 INPUT LOADING

No more than 1 standard TTL load
Low .8V max
High 2.0V min

1.3.9 FULL SCALE DEFLECTION AND SIGN CONVENTION

(10% + Trim Error; Total allowable tolerance)

	Control Pulse Width	
Servo/Linkage	1.0 + .01 msec	1.8 + .01 msec
Elevator	6.7° to 9.3° T.E.D.	6.7° to 9.3° T.E.U.
Left Aileron	12.75° to 17.25° T.E.U	8.25° to 11.75° T.E.D.
Right Aileron	8.25° to 11.75° T.E.D.	12.75° to 17.25 T.E.U.
Rudder	21.5° to 28.5° T.E.L.	21.5° to 28.5 T.E.R.
Throttle	Engine Idle	Engine Max

1.3.10 Control surface travel shall not be mechanically restricted for inputs of 0.95 to 1.85 msec.

1.3.11 SERVO/LINKAGE TEST PROCEDURE

1.3.12 PULSE WIDTH CONTROL

- Unless otherwise specified
  Input - 1.4 ± .01 msec at 62.5 ± 1.0 Hz
  Supply voltage 28 ± .5 VDC

1.3.13 BACKLASH

- Determine peak to peak backlash (backlash or hysteresis) in degrees using approximately ± 0.1 ft-lb torque on each control surface.

1.3.14 TORQUE

- Each servo shall be capable of providing the specified torque without exceeding the specified supply current.

1.3.15 FREQUENCY RESPONSE

- Modulate 1.4 msec control pulse at 62.5 Hz with sine wave of 0.177 msec peak.
- Measure peak-to-peak deflection of servo.

1.3.16 POSITION DRIFT DUE TO TEMPERATURE

- Test to be run on servo only.
- Run tests at -10, 0, 20, 30, 40 and 50°C.
- Input - 1.4 ± 0.02 msec pulse width
  25±.5 VDC
- Soak at each temperature with power off for 1 hour minimum.
- Measure servo position after power on for no longer than 1 minute.
- Construct best fit exponential (French curve) through data points.
- Determine worst case slope.

1.3.17 TRIM

- Input - 1.4 ± 0.01 msec
- Determine the two positions of the control surface using ± 0.1 ft-lb torque (see backlash) applied to surface.
- Determine the average of the two values.

1.3.18 SCALE FACTOR

- Apply approximately 0.1 ft-lb torque at the control surface (1 way only).
- Measure surface position for pulse widths of 1.2 and 1.6 ± 0.01 msec.
- Scale factor - Difference (degrees) /0.4 msec.

1.3.19 FULL SCALE DEFLECTION

- Use same method in trim procedure to determine control surface positions at center of backlash for 1.0 and 1.8 ± 0.01 msec control pulse width (e.g.: if the rudder position for 1.0 ms measured 21.0° when 0.1 ft-lb torque is applied to the left, then the backlash is 1.5° and the average position is 21.75° which is within tolerance).

1.4 CONTROL SURFACE POSITION POTENTIOMETER SPECIFICATION

1.	Resistance	2K to 10K ohms
2.	Resistance tolerance	20% max
3.	Linearity	1.0% max
4.	Resolution	0.1 deg max
5.	Effective electrical angle	354 deg ± 2 deg
6.	Power rating	1 watt, min

NOTE: Control surface pot gear ratios shall be

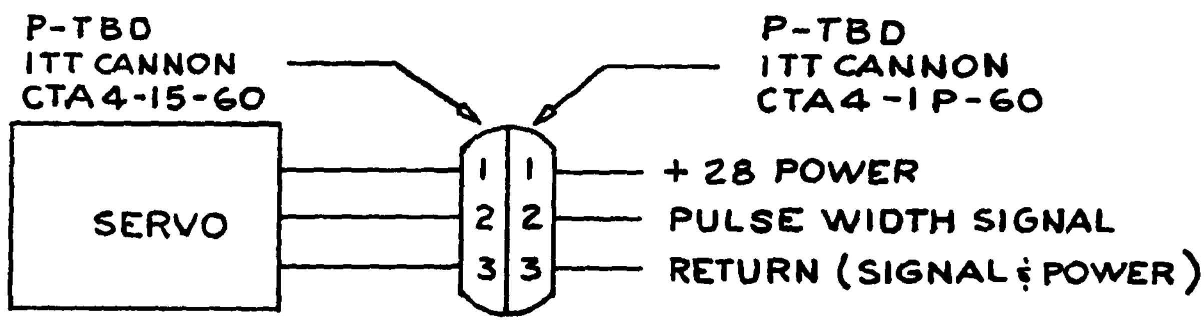
3:1 - Aileron and Rudder

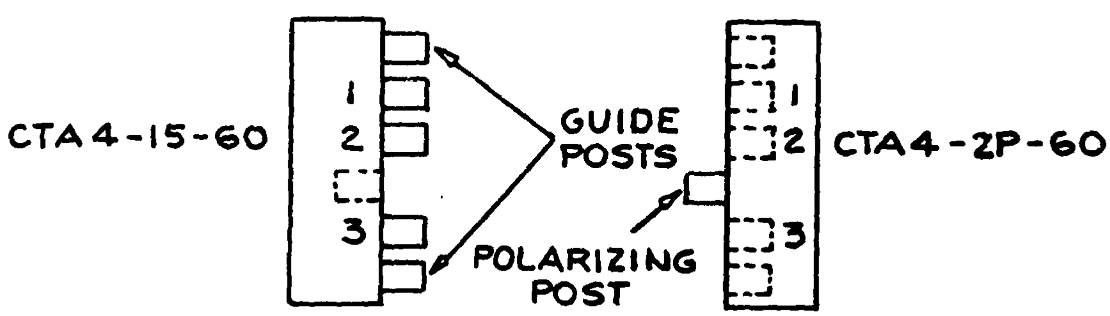
4:1 - Elevator
(gear and mechanical linkage ratio)

±10%

1.5 MISCELLANEOUS

1.5.1 SERVO INTERFACE





1.5.2 L BAND ANTENNA

- Frequency	1.43 to 1.73 GHz
- VSWR	2:1 max
- Polarization	Vertical ± 5 deg

1.6 ENVIRONMENTS

Ambient Temperature 1/	+20°F to +120°F
Relative Humidity	10 to 95 percent noncondensing
Launch Acceleration	10g peak, half-sine pulse, with 0.44 second time base in the longitudinal axis.
Landing Shock	15 g peak, half-sine pulse, with 0.050 second time base in the vertical axis.
Flight Vibration	2g's RMS discrete vibration from 20 Hz to 2KHz.
Flight Maneuvers	
Pitch	5.5 g's
Yaw	2 g's

1/ NOTE: Ambient temperature is temperature external to the mini-drone.

1.7 XBQM-106 SELL-OFF CHECKLIST

TAIL NO. ________

	INITIAL	
	VENDOR	AF
1. VEHICLE AND STRUCTURE		
A. General structural assembly		
1. Fuselage	____	____
2. Nose shroud (fit and mounting)	____	____
3. Ventral and tail skids	____	____
4. Horizontal stabilator and counter weights	____	____
5. Rudder and hinging	____	____
6. Elevator linkage	____	____
7. Wings (including aileron and hinging)		
a. left	____	____
b. right	____	____
8. Engine fairing (fit and mounting)	____	____
9. Paint	____	____
10. Wing spar (material and size)	____	____
11. Tail spar and pin (material and size)	____	____
12. Access panels (fit and mounting)	____	____
a. Fuselage (left and right)	____	____
b. Elevator, rudder, and elevator pot.	____	____
c. Wing servos and pitot		
Left	____	____
Right	____	____
13. Wing tips (fit and mounting)	____	____
14. Fin cap (fit and mounting)	____	____
15. Subrudder	____	____
16. Side force fins and pins	____	____
17. Engine, mount and propeller	____	____
18. Engine run check	____	____
B. Structure - Functional		
1. Elevator alignment, fit, and movement	____	____
2. Rudder alignment, fit, and movement	____	____
3. Throttle linkage and movement	____	____
4. Wing		
a. Incidence	____	____
b. Spar and fuselage fit	____	____

c. Anti-rotation pin fit and retainer bolts ________ ________
d. Aileron alignment, fit and movement ________ ________
5. Fuel System
a. Fuel tank installation ________ ________
b. Fuel tank leak check ________ ________
c. Feed and vent lines ________ ________

2. AVIONICS
A. Preinstallation Checks
1. Batteries (cycle and rap test) ________ ________
2. Wiring (quality and functional) ________ ________
3. Servos (functional and run in)
a. Rudder ________ ________
b. Elevator ________ ________
c. Aileron ________ ________
d. Throttle ________ ________
4. Alternator and regulator burn in ________ ________
5. Antenna ________ ________
6. Leave Bracket ________ ________
7. Ignition burn in ________ ________
8. Pitot and static pressure lines (wing and fuse) ________ ________
9. Pitot tube
B. Physical Installation
1. Inspect and tighten each servo output arm, push rod, and linkage
a. Rudder ________ ________
b. Elevator ________ ________
c. Left Aileron ________ ________
d. Right Aileron ________ ________
e. Throttle ________ ________
2. Inspect and tighten physical installation of all other equipment
a. Switches and charge plug ________ ________
b. Antenna and coax ________ ________
c. Control surface position pots ________ ________
Left aileron ________ ________
Right Aileron ________ ________
Rudder ________ ________
Elevator ________ ________

d. Propulsion

Engine mount ________ ________

Engine ________ ________

Alternator coupling ________ ________

Alternator ________ ________

C. Functional Checks

1. Centering, movement and direction of servos and control surfaces. See Section 1.3 for checkout and acceptance test requirements.

a. Left aileron ________ ________

b. Right aileron ________ ________

c. Elevator ________ ________

d. Rudder ________ ________

e. Throttle ________ ________

3. MASS PROPERTIES - See Appendix A for mass properties data requirements.

COMPONENT LOG TAIL NUMBER

ITEM	PART NO.	SERIAL NO.
Regulator		
Ignition		
26V Lead Acid Battery		
Rudder Servo		
Elevator Servo		
Left Aileron Servo		
Right Aileron Servo		
Throttle Servo		
Antenna		
Engine		
Alternator		
Propeller		
Fuel Filter		
Surface Pots		
Engine Mounts		
Pitot Tube		

DATA SHEET 1

MINI-DRONE CHECKOUT SHEET; TAIL NO. ____________.

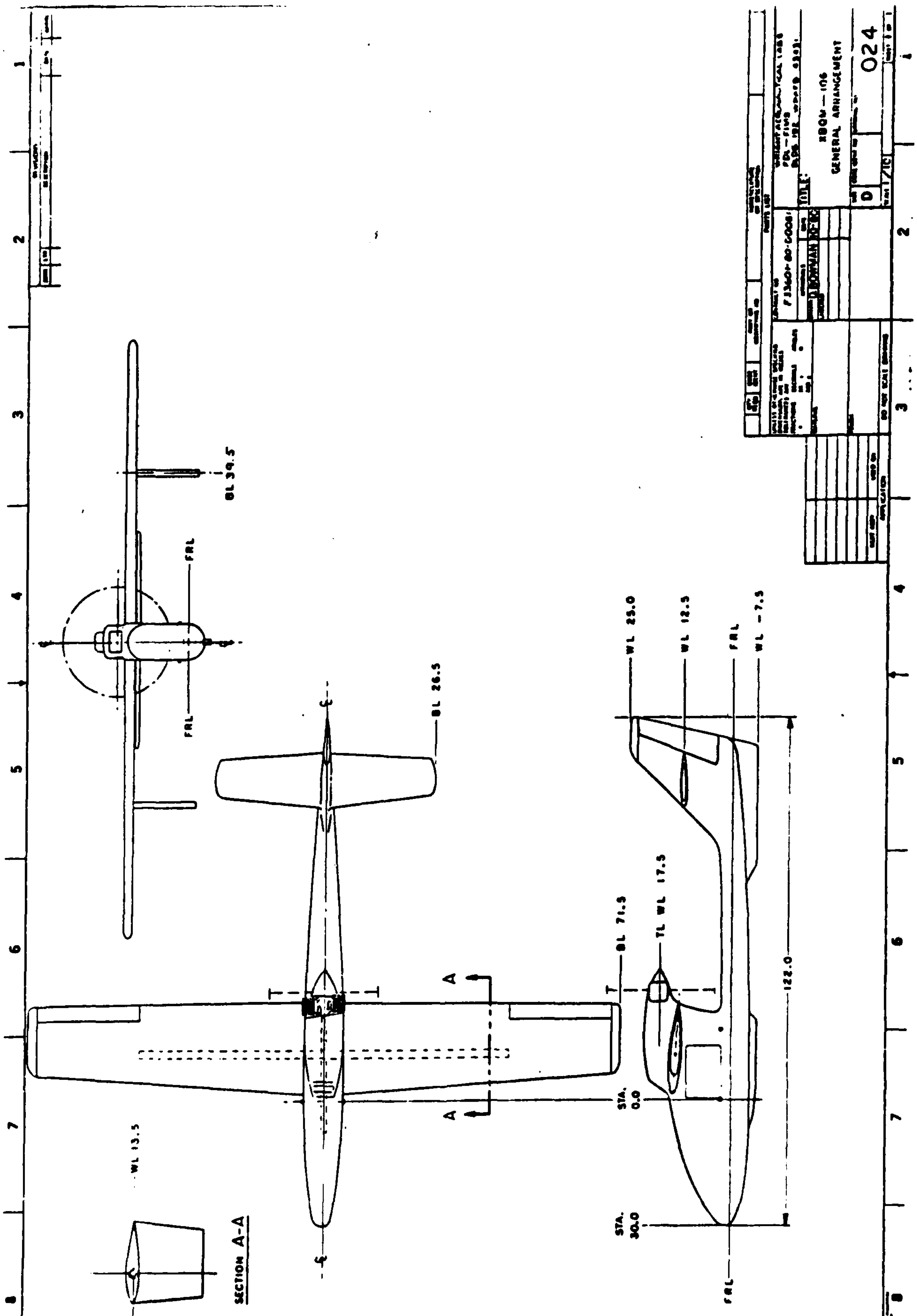
Control Surface	Position Pot Output	Pulse Width Input 1.0 ms	1.2 ms	1.4 ms	1.6 ms	1.8 ms	Backlash pk to pk
Elevator	Degrees						
	Volts						
Left Aileron	Degrees						
	Volts						
Right Aileron	Degrees						
	Volts						
Rudder	Degrees						
	Volts						
Throttle							

1.8 SPARES

The following list describes a recommended list of spares for 3-aircraft flight test program. These items are in addition to the three complete airplane ship-sets.

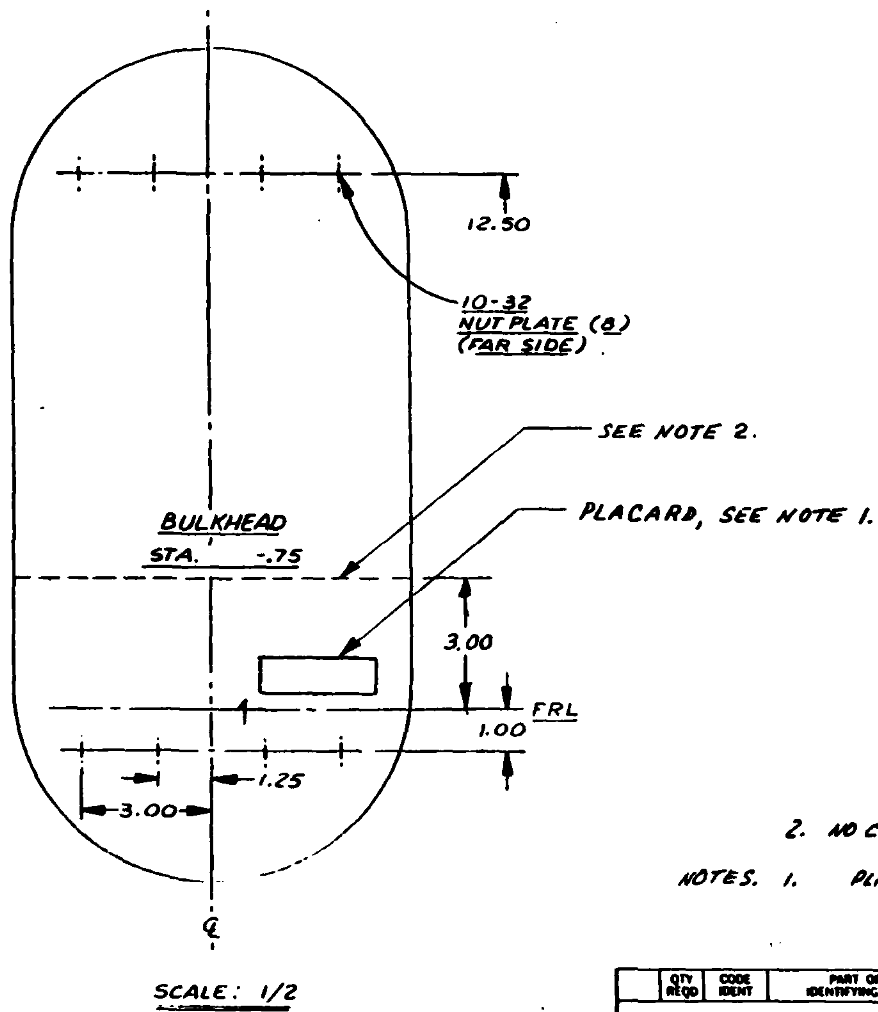
PART NAME	QUANTITY	REMARKS
Landing Skid	6	
Sub Rudder	12	
Side Force Fins	12	6 sets
Side Force Spars	4	1 set
Propeller	1	
Engine (DH 220)	1	
Spark Plugs	4	
Ignition Assy.	1	
26V Battery Pack	1	
Voltage Regulator	1	
Servos	4	
Alternator	1	

The spares set shall be packaged in a reusable, field accessable packing container.


BL 39.5
FRL
FRL
BL 26.5
WL 25.0
WL 12.5
FRL
WL -7.5
BL 71.5
TL WL 17.5
122.0
STA. 0.0
STA. 30.0
FRL
WL 13.5
SECTION A-A
XBQM—106
GENERAL ARRANGEMENT
024
DO NOT SCALE DRAWING

A44

Figure 1



NOTES. 1. PLACARD INSCRIPTION: "NOTE TO INSTALLER, 10-32 FASTENERS SHALL NOT EXTEND MORE THAN 5/8" INTO BULKHEAD TO AVOID DAMAGE TO FUEL TANK."

2. NO CUTOUTS IN BULKHEAD BELOW THIS LINE.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

NEXT ASSY | USED ON

APPLICATION

DO NOT SCALE DRAWING

CONTRACT NO F33601-80-D0081

APPROVALS | DATE

DRAWN D.BUWMAN | 9-30

CHECKED

WRIGHT AERONAUTICAL LABS
FDL-FIMS
BLDG. 192 WPAFB 1-431

BULKHEAD

FUSELAGE STA -0.75

SIZE C | CODE IDENT NO | DRAWING NO 10239

SCALE 1/2 | SHEET 1 OF 1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED

A4/5

Figure 2

MINI-DRONE AVERAGE MASS PROPERTIES

(Average - Tail Nos. 18-22)

Fuselage [1/]	25.89
Left Wing and Harness	8.14
Right Wing and Harness	8.33
Wing Spar	7.66
Left Stabilator	1.28
Right Stabilator	1.28
Stabilator Spar	.28
Mass Balance - Left	.22
Mass Balance - Right	.22
Left Side Force Fin and Pin	.50
Right Side Force Fin and Pin	.50
Engine Fairing	.99
Nose Shroud (Have Pawn)	3.09
Stabilator Servo and Linkage	.55
Left Aileron Servo and Linkage	.55
Right Aileron Servo and Linkage	.55
Throttle Servo and Linkage	.48
Ignition (including cables)	2.41
Rudder Servo and Linkage	.55
Antenna	.12
Engine Mount	3.28
Engine	13.80
Propeller	1.29
Alternator with Coupling	6.22
Magnetometer and Mount	.30
+26V Lead Acid Battery Pack	5.81
Pitot Tube	.15
Subrudder	.43
Regulator	.28
	95.15 Empty Weight

[1/] Fuselage includes ventral skid, tail skid, gas tank, wing anti-rotation pin, and tail harness.

Figure 3

APPENDIX A

MASS PROPERTIES

Mass properties (weight) for those elements of the mini-drone listed in Table A-1 shall be provided. Mass properties for the remaining mini-drone elements shall be provided to AFWAL so that AFWAL can provide a total vehicle mass properties estimate.

APPENDIX A

TABLE A-1. MINI-DRONE MASS PROPERTIES

Item	Weight (lb)	CG (in) x	y	z
Fuselage 1/				
Left Wing and Harness				
Right Wing and Harness				
Wing Spar				
Left Stabiliator				
Right Stabilator				
Stabilator Spar				
Mass Balance - Left				
Mass Balance - Right				
Left Side Force Fin and Pin				
Right Side Force Fin and Pin				
Engine Fairing				
Nose Shroud				
Stabilator Servo and Linkage				
Left Aileron Servo and Linkage				
Right Aileron Servo and Linkage				
Throttle Servo and Linkage				
Ignition (including cables)				
Rudder Servo and Linkage				
Antenna				
Engine Mount				
Engine				
Propeller				
Alternator with Coupling				
Magnetometer and Mount				
+26V Lead Acid Battery Pack				
Pitot Tube				
Subrudder				

1/ Fuselage includes ventral skid, tail skid, gas tank, wing anti-rotation pin, and tail harness.

APPENDIX B
TEST PROCEDURES

Engine Run Test
Herbrandsen DH-220

Tests: 1. Inspection.
2. Run Up.

Procedure:

1. Upon receipt from factory, the engine is inspected for defects.

a. A visual check is made for casting flaws, misalignment, missing parts such as piston rings, carburetor needles, etc., and to verify proper part sizes such as propeller flange and carburetors. A visual check for foreign objects in the cylinder is made by looking through exhaust ports and spark plug holes.

b. The crank shaft is rotated to check for binding or roughness in the moving parts of the engine.

2. After passing defect inspection, the engine and an Air Force ignition system are mounted on the static test stand in the FIMS engine cell. A test propeller (either a 28-11 or a cut down 28-13) is mounted in a pusher configuration. Leaded gasoline and Klotz synthetic oil are provided in a ratio of 13 to 1.

a. The engine is started and warmed up at idle RPM for a minute or two.

b. When warm, the engine is opened to full throttle and RPM is checked with an optical tachometer. Peak RPM should be 6400 to 6800.

c. After one minute of full throttle running the RPM is checked again. It should not have dropped more than 100 RPM.

d. Idle is reestablished and the engine is stopped by grounding the ignition system.

e. Repeat procedures 1a and 1b after engine has cooled.

4. This completes engine acceptance testing.

FUEL TANK LEAK TEST

1. Pressure Test

   a. Plug or cap fuel pickup line.

   b. Pressurize tank to 1-2 PSIG. Maintain constant pressure.

   c. Immerse tank in water tank and check for air bubbles.

   d. If no bubbles are detected, proceed to fuel test.

   e. If bubbles are detected, locate and mark locations - proceed to repair section.

2. Fuel Test

   a. Fill tank 1/2 full of gasoline (no oil).

   b. Cap vent and pickup lines and rotate tank to thoroughly wet inner surfaces with fuel.

   c. Shake tank slightly to volatize some fuel and cause tank to be pressurized.

   d. Inspect outside of tank for wetness.

   e. If wetness is detected, drain tank and mark for repair, otherwise drain and install.

3. Repair

   a. Lightly sand exterior surface at point of leak and saturate with epoxy resin.

   b. Cut small opening in top of tank near leak and pour in small quantity of tank sealer (MIL-S-4383B).

   c. Slosh sealer thoroughly in area of leak, pour out excess.

   d. Repair opening in tank with epoxy/fiberglass patch, at least 3x diameter of hole.

   e. Repeat Pressure Test and Fuel Test.

Ignition System Acceptance Test

Tests: 1. Manufacturers test data.
2. Operational test.
3. 28 volts DC supply current check.
4. RFI test.

Procedure:

1. Factory test data will be accepted for burn-in and function test.

2. Operational test.

   A. Connect ignition high voltage cables to a set of 0.025" gapped spark plugs that are installed in a pressure test chamber.

   B. Apply 90 psi air from dry air source, to air chuck nipple on test chamber.

   C. Connect ignition to 28 volts DC supply and to simulator, turn power on and observe presence of a brilliant spark at each plug.

   D. Increase RPM from minimum of 1,200 to 8,000 RPM and observe spark. It should be steady and brilliant.

3. 28 volt DC supply current check. Power supply current @ 28 VDC and 8,000 RPM should be less than 1.2 amps.

4. RFI test.

   A. Using a spectrum analyzer and a search loop antenna, check for radiation from ignition in excess of -70 dbm, 10 MHz to 2 GHz while under operating conditions and at a distance 6".

   B. Disconnect ignition from power supply then from test chamber.

5. This completes the ignition system test.

28 Volt Servo

Tests: 1. Performed during calibration.
2. Cycle test and burn-in
3. Final Test.

1. Servo is initially set-up using "0" torque load and a minimum voltage of 10 volts.

A. Mechanical zero is determined by rotating output shaft to ½ way between stops.

B. Set zero trim pot to center of rotation.

C. Install servo in test fixture, power is applied, adjust feedback potentiometer for a center of $0^{\circ} \pm 1^{\circ}$.

D. Apply 28 VDC with a current limit on supply set at 1 ampere.

E. Using a 1.0 Msec control pulse check deflection of (45° + zero) $\pm 1.5^{\circ}$.

F. Using a 1.8 Msec control pulse check deflection of (-45° + zero) $\pm 1.5^{\circ}$.

G. Minimum pulse width.

1. Connect oscilloscope vertical input to output of amplifier (red wire of motor) and ground and + trigger input to pulse command input.

2. Install servo on torque stand with "0" torque load and rotate output and observe minimum pulse.

3. Minimum pulse should be 0.9 Msec to 1.5 Msec.

H. Maximum torque test.

1. Set torque stand for 16 in. lb. at 25° travel.

2. Install servo in torque stand and apply 28 volts power.

3. Connect oscilloscope vertical input to output of amplifier (red wire of motor) and + trigger to pulse command.

4. Input a 1.8 Msec pulse command and then 1.0 Msec pulse command.

5. At stall maximum pulse width should be 7 to 9 Msec, based on a 62.5 Hz repetition rate (16 Msec).

6. Disconnect test equipment, inspect servo for gear train damage, and then assemble servo, except for rear cover.

2. Servo cycle test.

   A. Connect 5 servos at a time to cycler test set.

   B. Apply 28 VDC power.

   C. Cycle for 8 hours.

   D. Duty cycle is one, 0 to $+45^{\circ}$ to $\pm 45^{\circ}$ to 0, cycle in 5 seconds.

   E. At completion of cycle disconnect power and servo cycler test set.

3. Final acceptance test of the servo is accomplished by measuring its zero.

   A. Install servo on test stand and apply power.

   B. With "0" torque load measure zero, and if required trim to zero with zero trim potentiometer (1.4 Msec pulse command).

   C. Apply 1.8 Msec command, deflection = $45^{\circ} \pm 2.5^{\circ}$, record data and serial number.

   D. Apply 1.0 Msec command, deflection = $-45^{\circ} \pm 1.5^{\circ}$.

   E. Note: Total deflection $90^{\circ} + 5^{\circ}$, zero within $\pm 1.5^{\circ}$.

   F. Set 16 in. lb. load at 25° on torque stand.

   G. Apply 1.8 Msec check deflection of 25° - 3° to + 5°.

   H. Apply 1.0 Msec check deflection of 25° - 3° to + 5°.

   I. Disconnect power and remove from test stand.

   J. Verify no gear damage has occured.

4. End of test.

Regulator Factory Electrical Tests

Tests: 1. Performed during final assembly.
2. Burn-in.
3. Final test.

Procedure:

1. Test performed during final assembly.

   A. Regulator is run with a power supply and a load simulator. The regulator regulation point is adjusted to 28.5 volts.

   B. Operation is checked at 22 to 32 volts (regulates at 28.5 volts).

   C. Over voltage protection is checked to be at least 33 volts and less than 35 volts.

2. Burn-in test is performed at 28 volts for a period of 72 hours to detect infantile failures of electronic components.

3. Final test.

   A. Covers and label are installed.

   B. Tests 1B and 1C are repeated and data is recorded.

4. This completes the regulator test.

Ignition System Factory Electrical Tests

Tests:
1. Performed during final assembly.
2. Burn-in.
3. Final test.
4. Acceptance test.

Procedure:

1. Calibration checks and operational tests are run by installing a set of aircraft cables with spark plugs connected in the coil, a power supply capable of 28 VDC at 1.5 amps, and a trigger simulator (simulator is set to 2,000 RPM).

   A. Power is turned on, an oscilloscope is connected to Q1 or Q2, and DC-DC converter square wave overshoot is measured (should be less than 20%).

   B. Vary supply voltage from 15V to 38V @ 6,000 RPM and observe wave form of DC-DC converter. Amplitude of square wave varies as 2 X input voltage.

   C. Connect scope probe to SCR anode (case tab of SCR). Minimum recharge voltage at 8,000 RPM is not down more than 5% from nominal 300 VDC.

   D. Leave scope probe connected to SCR and connect trigger to tachometer output. Low speed retard is checked by rotating simulator to 1,200 RPM and observing time difference, its value is not of importance, rotate simulator to 3,000 RPM, delay should decrease to less than 0.2 Msec above 2,500 RPM.

2. Burn-in - The burn-in is used to find infantile failures.

   A. System is assembled in its case and coils are potted.

   B. Plug gaps are set to 0.37 in.

   C. RPM on simulator is set to 6,000 RPM and supply voltage to 28 volts.

   D. Unit is operated 72 hours under these conditions. The box temperature will raise approximately 35°C above an ambient temperature.

3. Final test.

   A. At completion of burn-in a conducted radiation test is performed. An oscilloscope is used to determine if noise is present and to determine that it is below 50 mv @ 28V and 8,000 RPM from DC to 60 MHz.

   B. Ignition cover is removed and test 1 is repeated. If all functions check, the cover is reinstalled and data sheet is completed.

4. Acceptance test.

A. Connect ignition high voltage cables to a set of 0.025" gapped spark plugs that are installed in a pressure test chamber.

B. Apply 90 psi air from dry air source, air chuck nipple on test chamber.

C. Connect ignition to 28 VDC supply and to simulator, turn power on, and observe presence of a brilliant spark at each plug.

D. Increase RPM from minimum of 1,200 to 8,000 RPM and observe spark. It should be steady and brilliant.

E. Current draw should be less than 1.2 amp at 8,000 RPM.

F. Using a spectrum analyzer and a search loop antenna, check for radiation from ignition in excess of -70 dbm 10 MHz to 2 GHz while under operating conditions.

G. Disconnect ignition from power supply and then from test chamber.

5. This completes the ignition system test.

FACTORY WIRING ACCEPTANCE TEST PROCEDURE

Test Performed:

1. Physical and visual before installation in vehicle.
2. Physical and visual after installation in vehicle.
3. Continuity.
4. Functional Test.

Procedure

All wiring, cabling, connectors, coax and antenni will be inspected for conformance to vehicle final wiring assembly drawings, acceptance test procedures, and company quality assurance practice and procedures manual.

1. Physical and Visual Inspection Before Installation in Vehicle

   a. Correct wire type, insulation, stranding and color.
   b. Correct connector type, pins or sockets, insulator, and contact specification.
   c. Crimping tools should be checked with proper go-nogo gauges.
   d. Inspect terminated cables before pins or sockets are installed in connector shell for proper depth of wire insertion and acceptable wire insulation to contact gap. Acceptable gap size is 1/2 of wire gauge diameter.
   e. After assembly of connector continuity should be made to insure wire integrity and correct connector - contact insertion and location.
   f. Inspect cables for proper tying system such as Tie-Wrap or lacing.
   g. Coaxial cable will be checked for proper connectors and assembly procedure.
   h. Coaxial cable installations will be rejected if kinks or bend radius of less than 1/2 are present.

      NOTE: This is extremely important for proper performance of the command, video, and telemetry systems.

2. <u>Physical and Visual Inspection After Installation in Vehicle</u>

a. Inspect cables for proper connectors and pin or sockets.
b. Inspect cables for maximum wire insulation - contact gap.
c. Inspect cables for abrasion around airframe penetrations.

3. <u>Continuity Tests</u>

Continuity tests will be performed at completion of all wiring installation in vehicle.

a. All cables or wires will be checked for continuity according to proper vehicle wiring assembly drawings.
b. All cables or wire will be checked for short circuits from one conductor to any other conductor, from any conductor to any adjacent metallic structure and to any coaxial cables in the vehicle.

4. <u>Functional Tests</u>

At completion of continuity tests, a 100% functional test of the wiring harness will be accomplished.

a. Servo will be operated to check control surface positioning, for direction and accuracy. See Section 2.19.
b. Control surface potentiometers will be checked for proper operation and accuracy. See Section 3.0.
c. Magnetometer wiring will only be checked for continuity at this time because connector will be installed when magnetometer is installed in vehicle.

1.5 GHz Antenna Test

Tests: 1. Physical integrity before foaming.
2. VSWR @ 1.43 GHz, 1.53 GHz, and 1.73 GHz.

Procedure:

1. Physical inspection of the antenna includes blade angle with body, blade height from body, solder joints on all connections within the antenna, and proper type and assembly of connector.

2. VSWR check at 3 frequencies of operation will verify integrity of the antenna. Radiation pattern has been previously documented for this physical configuration.

Measure VSWR at transmitter frequencies as specified in Figures 1 and 2. Use formula below after forward power and reflected power are measured to calculate VSWR for each antenna.

$$VSWR = \frac{1 + \sqrt{\frac{PR}{PF}}}{1 - \sqrt{\frac{PR}{PF}}}$$

PR = reflected power

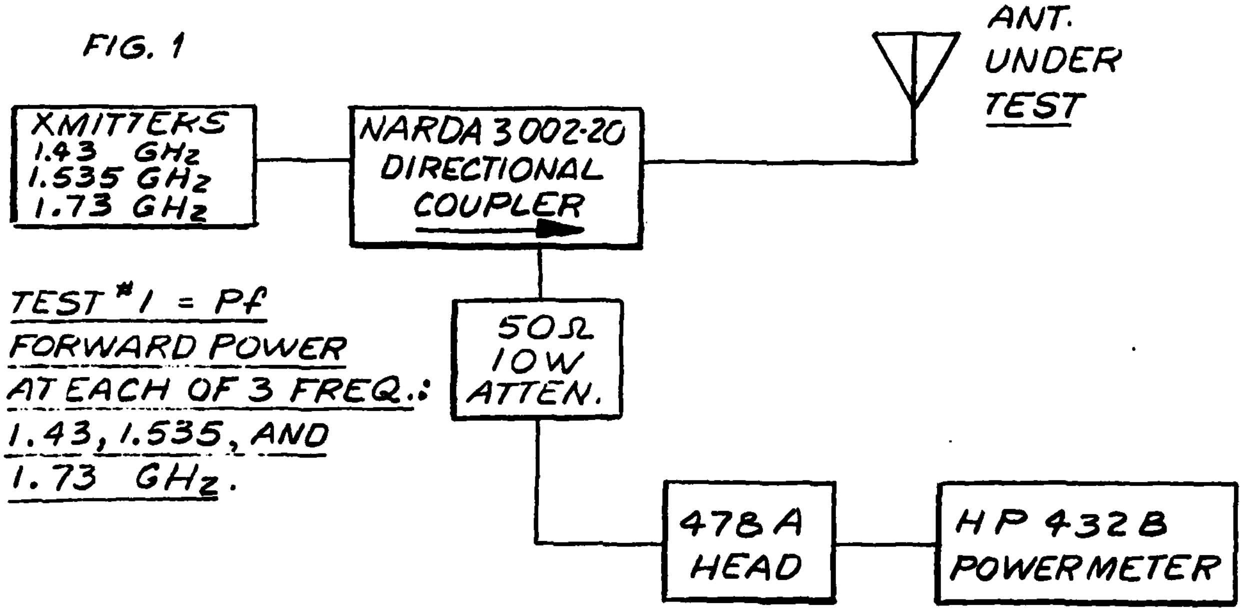
PF = forward power

A system wave ratio of 2:1 maximum is permitted.

3. This completes the 1.5 GHz antenna test.

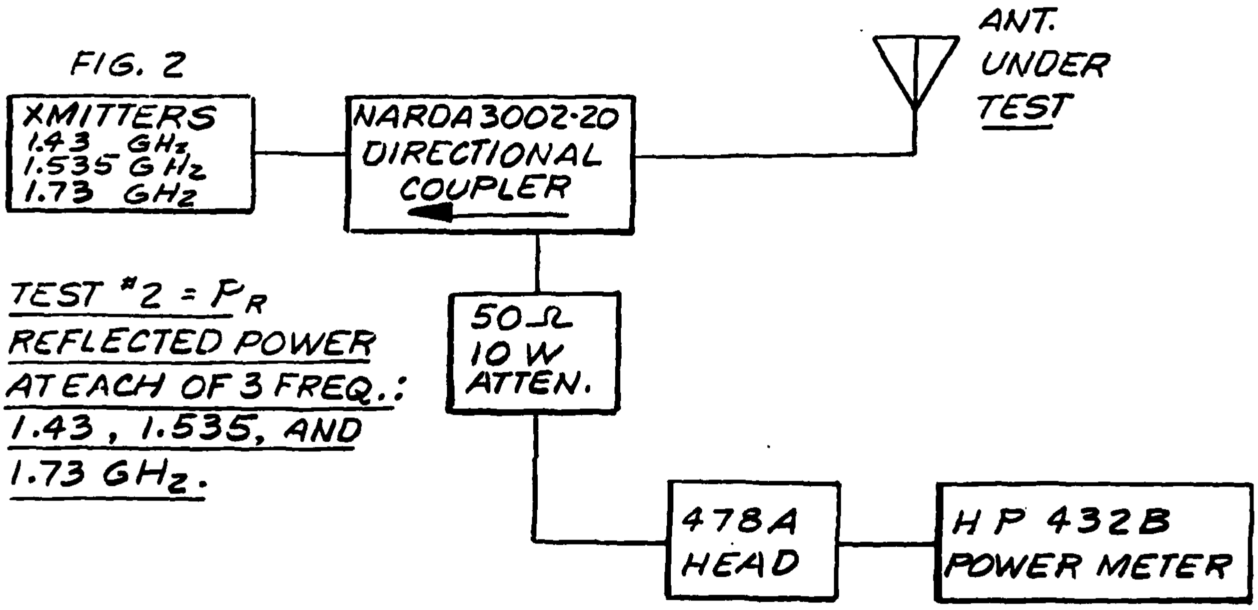
ANTENNA VSWR TEST

FIG. 1



TEST #1 = P_f
FORWARD POWER
AT EACH OF 3 FREQ.:
1.43, 1.535, AND
1.73 GHz.

FIG. 2



TEST #2 = P_R
REFLECTED POWER
AT EACH OF 3 FREQ.:
1.43, 1.535, AND
1.73 GHz.

$$VSWR = \frac{1 + \sqrt{\frac{P_R}{P_f}}}{1 - \sqrt{\frac{P_R}{P_f}}}$$

FOR EACH OF THE 3 FREQ.

MAX. VSWR = 2:1

Regulator and Alternator Test AFWAL/FIMS

Tests: 1. Operational test.
2. Verification test.
3. Operational test.

Procedure:

1. Operational test.

A. Alternator and regulator are mounted to an alternator test stand, the regulator is connected to the alternator, load, and a test set that is wired to simulate a XBQM-106 power system.

B. The load bank is set for a load current of 14 amps ± 1 amp.

C. Test stand is run up to 5,000 RPM and test set is energized.

D. Voltage is checked to be 28.2 volts to 28.5 volts at load test points.

2. Verification test.

A. The alternator/regulator is run for a period of 8 hours to verify operation of power system.

3. Operational test.

A. Test 1D is repeated at conclusion of operational test.

B. Ripple voltage on the buss is checked with an oscilloscope and must be less than 0.25 volt at 4,500 RPM, 5,000 RPM, and 8,000 RPM, and 17 amps ± 1 amp and 28 volts DC.

4. This completes the test.

Battery Tests at AFWAL/FIMS

Tests: 1. Rapp test.
2. Capacity test.

Procedure:

1. Rapp test of each individual cell is performed by striking the cell with a rawhide mallet in three directions side, side, and bottom. A load resistor of 22 ohms is used to give approximately 0.1 amp of current and an oscilloscope set on 0.5 volts/div AC range is used to monitor each cell as tested. Any noisy cells that are exhibited by any visible voltage ripple on the oscilloscope are discarded. (Note: Cells are normally shipped charged).

2. Capacity test of the cells is performed after the cells are assembled into a battery pack. The battery assembly of 13 cells is charged at 31.5 volts for 14 to 16 hours with current limited to 1.0 amp. At the completion of the charge a capacity test is run by discharging the battery at 1.25 amps (C/2) to a 1 volt per cell final voltage. The minimum acceptable capacity is 1.67 ampere hour.

3. This completes the battery test.

APPENDIX C

PERFORMANCE DATA

PERFORMANCE

CONDITIONS:

Gross Weight - 140#

Engine - McCulloch Mc101A

Propellor - 24 1/2" D X 13" Pitch

PERFORMANCE:

Takeoff Unassisted - 750 Ft

Takeoff Bungee Assisted - 400 Ft

Pneumatic Launcher - 10G. Max

Velocity

Takeoff	-	74 Ft/Sec
Land	-	80 Ft/Sec
Stall	-	67 Ft/Sec
Cruise	-	105 Ft/Sec
Max Level	-	150 Ft/Sec
Max Dive	-	300 Ft/Sec

Climb 900 Ft/Sec

VARIATIONS:

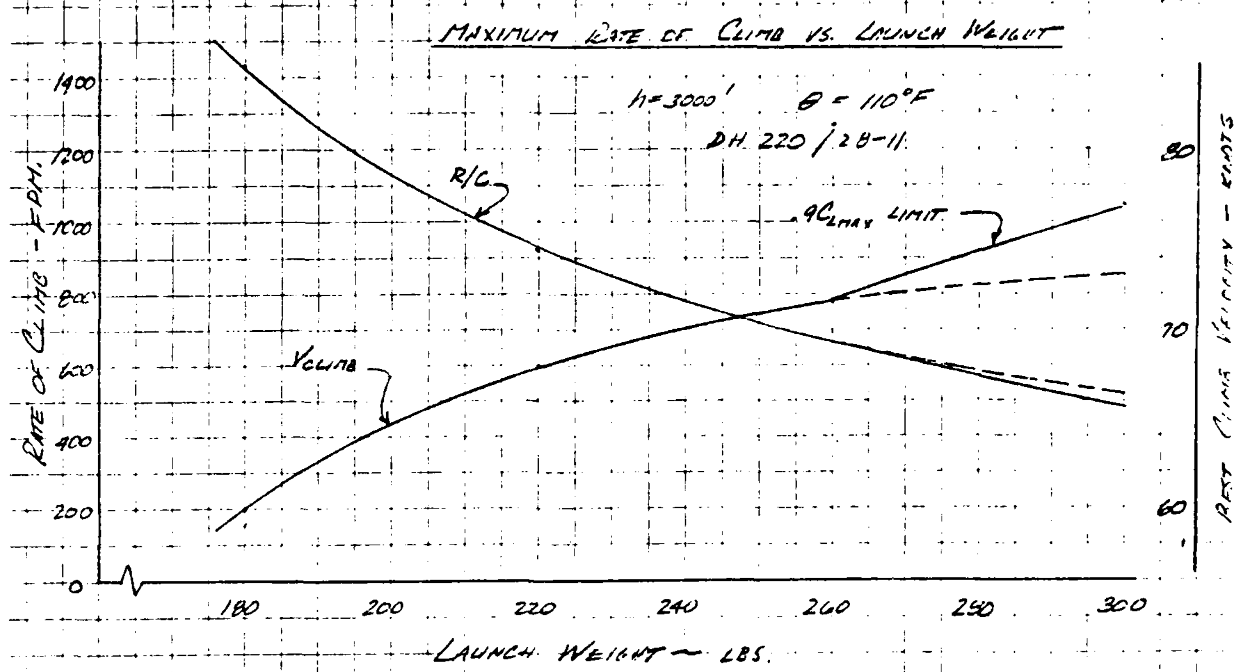
Engines - DH 220 (18 HP) use above 160# G.W.

Gross Weight - 130-225#

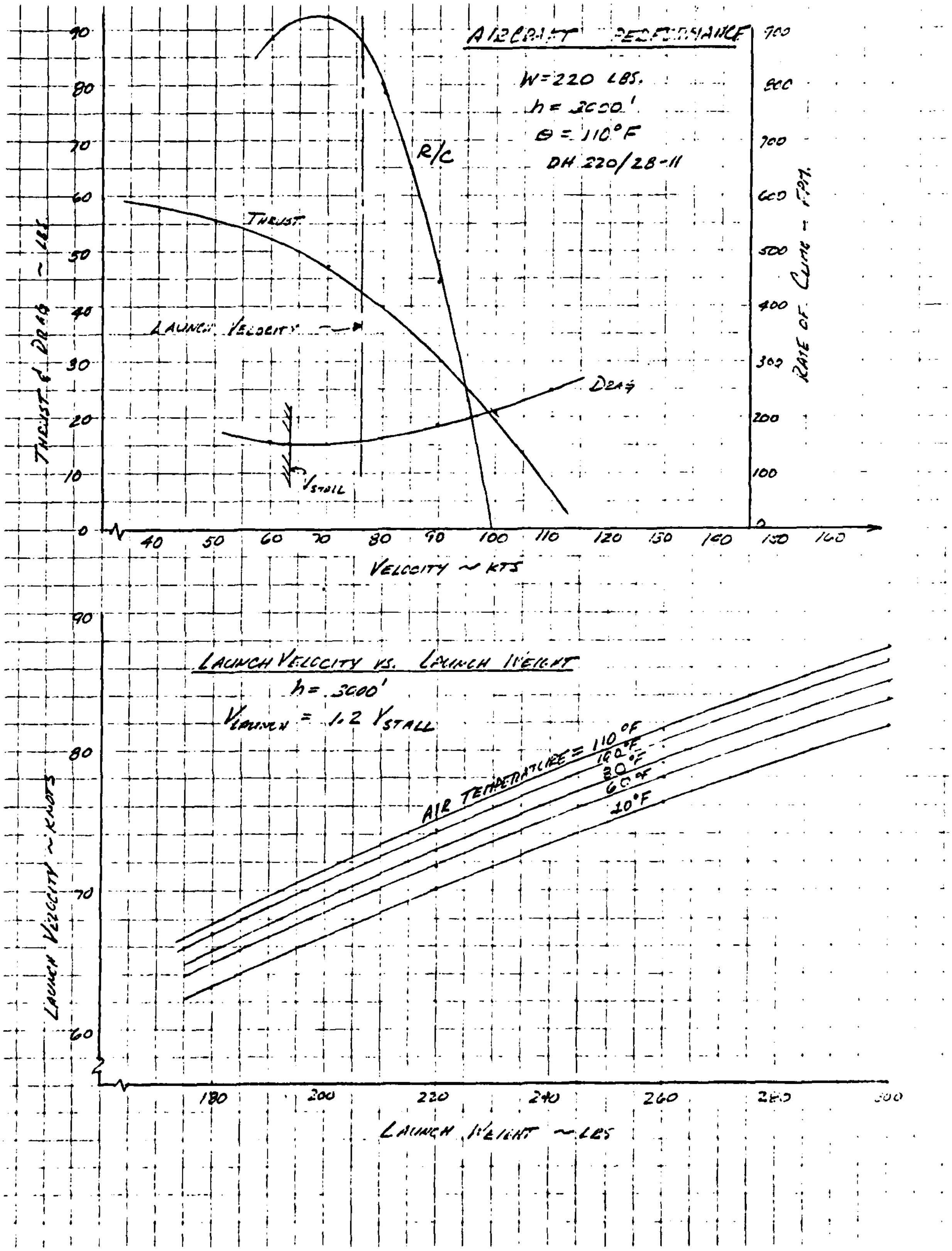
Payload - 45 - 110# (including fuel)

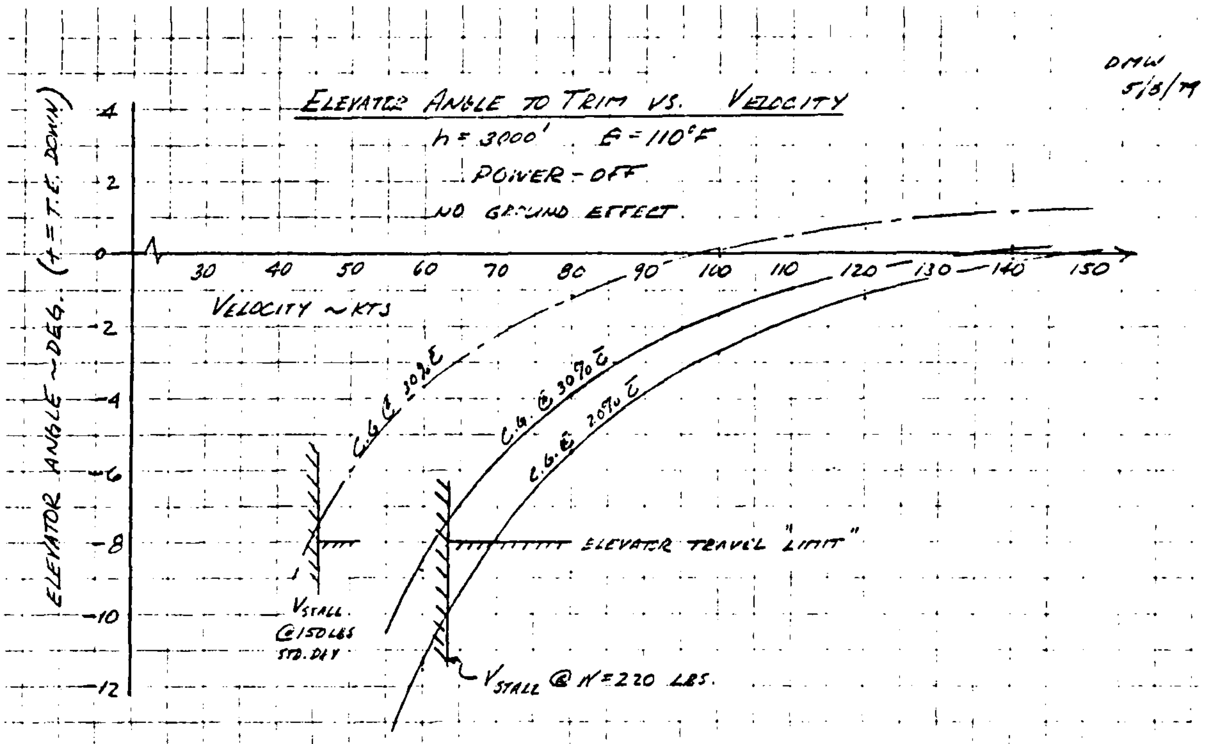
Fuel Capacity - Up to 8 gal (volume limit)

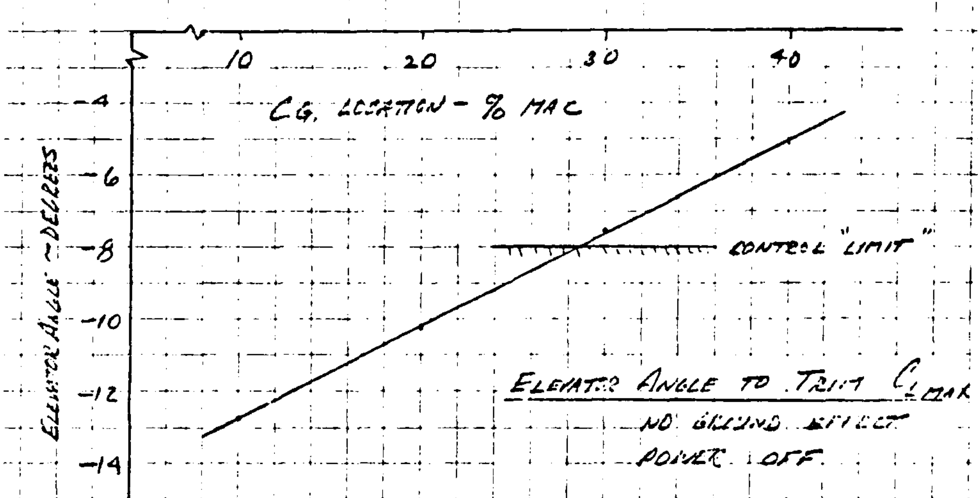
DMW 5/9/74



MAXIMUM RATE OF CLIMB VS. LAUNCH WEIGHT
h = 3000'   θ = 110°F
DH 220 / 28-11
R/C
.9 C_{Lmax} LIMIT
V_{CLIMB}
RATE OF CLIMB - FPM.
1400
1200
1000
800
600
400
200
0
180
200
220
240
260
280
300
LAUNCH WEIGHT ~ LBS.
BEST CLIMB VELOCITY - KNOTS
80
70
60


AIRCRAFT PERFORMANCE
W=220 LBS.
h = 3000'
θ = 110°F
DH 220/28-11
R/C
THRUST
LAUNCH VELOCITY
DRAG
V STALL
THRUST & DRAG ~ LBS
RATE OF CLIMB ~ FPM
VELOCITY ~ KTS
LAUNCH VELOCITY VS. LAUNCH WEIGHT
h = 3000'
V LAUNCH = 1.2 V STALL
AIR TEMPERATURE = 110°F
100°F
80°F
60°F
40°F
LAUNCH VELOCITY ~ KNOTS
LAUNCH WEIGHT ~ LBS


DMW
5/8/79
ELEVATOR ANGLE TO TRIM VS. VELOCITY
h = 3000' θ = 110°F
POWER - OFF
NO GROUND EFFECT
ELEVATOR ANGLE ~DEG. (+ = T.E. DOWN)
VELOCITY ~KTS
C.G. @ 30% c̄
C.G. @ 20% c̄
ELEVATOR TRAVEL "LIMIT"
VSTALL @150 LBS STD. DAY
VSTALL @ W=220 LBS.


C.G. LOCATION - % MAC
ELEVATOR ANGLE ~DEGREES
CONTROL "LIMIT"
ELEVATOR ANGLE TO TRIM $C_{L_{MAX}}$
NO GROUND EFFECT
POWER OFF